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Forthcoming Events.

JANUARY 1.

Junior Institution of Engineers:—Ordinary meeting in London. Paper on "The Rolling Mills and Crucible Melting Department."

JANUARY 5.

Institute of Metals (Birmingham Local Section):—Ordinary meeting in Birmingham. "The Influence of Work and Annealing on Brass," Paper by O. F. Hudson, D.Sc.

Institution of Automobile Engineers:—Ordinary meeting in London. "Sleeve-Valve Engine Development," Paper by W. Ferrier Brown.

JANUARY 6.

Institute of British Foundrymen (Wales and Monmouth Branch):—New Year's smoking concert at Swansea.

FEBRUARY 15-26.

British Industries Fair, 1926:—London and Birmingham.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Trades Equipment & Supplies Association.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Retrospective 1925.

We propose to review the principal events of the passing year from two aspects, the technical and the trade.

Of outstanding interest on the technical side has been the putting into actual commission and the commercial exploitation of what has become known as the Perlit process. It has aroused some rather pronounced views, but beyond everything else it has focussed attention to a phase of metallurgy, the close examination of which is bound to react favourable upon the better appreciation of basic constitution of cast iron. Another special iron has, without the addition of special elements, registered nearly 27 tons tensile. This sounds excellent from old-fashioned standards, but we have recently had details of a high chromium cast iron which will, after heat treatment, give 50 tons. We expect much more will be heard of this alloy in the near future.

The Cast Iron Research Association is now making definite progress. It has every appearance of being in a position to carry on in the near future without help from the Department of Scientific and Industrial Research. Both Mr. Pearce and Mr. Fletcher are to be congratulated on the splendid progress achieved, especially in having assured for their Association the good will of the most prominent firms in the industry.

The Institute of British Foundrymen again shows a widening sphere of interest. It enjoys the respect and collaboration of all other allied technical bodies. A new section has been formed in Paisley, and new junior sections in both Lancashire and Birmingham.

An undesirable phase has recently presented itself. For years the metallurgists have asked the foundryman to take an interest in the metallurgical side of foundry work. He has done so, and now when he expresses a metallurgical opinion he is liable to be labelled an "amateur" metallurgist. This is totally a wrong attitude to assume, and those adopting it must for the general good of the industry encourage further study of metallurgy by the practical man.

The Glasgow Conference was run on very ambitious lines, and examined from no matter what angle it must be granted that it was exceptionally successful. Mr. John Cameron, the popular president, is to be congratulated on having such an efficient secretary as Mr. John Bell as the organiser of this meeting.

The foreign relations of the Institute have been maintained with America, France and Belgium, whilst the Institute was unofficially represented by its president and many members of council at the Düsseldorf Foundry Exhibition.

Coming now to trade conditions, the export of builders' castings has been maintained at a definitely higher level than in 1924, whilst business in pipes has remained practically stationary, the losses in Indian, Australian and South African trade being practically counterbalanced by increased business with "other countries."

Judging purely from the standpoint of the buying of pig-iron and scrap, the iron foundries have been badly hit during the past year. But is this fair basis? If all the light industries were busy and the foundries attached to blast-furnace plants were working at full pressure, the pig-iron market reports would proclaim a decadent industry. An examination of the present industrial conditions must envisage somewhat parallel conditions. Shipbuilding castings have not been in any serious demand, whilst orders for railway chairs—a casting which eats up tonnage, have been less than what is to be

considered normal. The foundries making light castings for building purposes have been generally working with a full order book. Agricultural implement makers' foundries have been slack, but even here a slight improvement in certain sections has been shown. The electrical engineers foundries have recently picked up again and a certain amount of work has been given to outside foundries. Pipe foundries have been reasonably well employed, whilst those catering for the mining industry have been very short of work since the beginning of the subvention. Some improvement has been shown during the last quarter in the foundries catering for the metallurgical and chemical industries, whilst those attached to or working for the automobile factories have been kept fairly well occupied. Textile foundries have recently experienced a slight improvement.

Of jobbing foundries it is difficult to speak, but those catering largely for the engineering trades have shown some improvement. Most of the London foundries are kept reasonably busy, but at starvation prices.

Progress, as shown by the equipment trades, is satisfactory without being really good. The sandslinger has made a number of important sales in Great Britain. The hydraulic moulding machines continue to register important Dominion sales. Much attention is being devoted to sand and shot blast and several modern plants have been installed during the year. The Cleaning of Castings Regulations which recently came into force is causing the reorganisation of many shops. Where due regard is paid to transport these alterations may very easily pay for themselves. Core and mould drying furnaces too, have had much attention bestowed upon them by the industry, and a number of modern installations have been made. The crane makers are at last realising the importance of the foundry trade as a market for their goods and are designing apparatus of special suitability. Conveying apparatus has not yet received the whole-hearted attention it deserves, but we are cognisant of some new developments of which we have great hopes that the real needs of the industry will be met.

The malleable iron foundry industry has been patchy, the larger firms have done well, but some of the smaller ones have been so poorly remunerative that they have closed down. American competition in this line is severe and likely to increase unless adequate steps are taken. The import of the word "adequate" is obviously a contentious one.

The steel castings industry has remained stationary, and is in certain districts, especially Glasgow, being subjected to German competition at ridiculous prices. The German firm's representative has stated that they take on the British orders to keep down their overheads, as their domestic prices are quite favourable. This acceptance of non-profit-bearing orders to lower overheads is more often than not a fallacy and is more likely to lead to the Bankruptcy Court than the prosecution of a successful business.

Obituary.

MR. H. B. SPARROW, of H. B. Sparrow & Company, metal merchants, 65, Fenchurch Street, E.C.3, died recently, aged 61.

MR. B. BIRD has died at his residence at Stourbridge Road, Halesowen, in his 85th year. For 60 years he was a representative of Miles, Druce & Company, Upper Thames Street, London, iron and steel merchants, until he retired a few years ago.

MR. W. J. BEDFORD, a member of one of the oldest of Sheffield families, and managing director of John Bedford & Sons, Limited, crucible steel manufacturers, Lion Works, Mowbray Street, Sheffield, died last week. He lived in Graham Road, Ranmoor, and was the youngest of the three sons of the late Mr. John Bedford, of Bolsterstone. He was in his 77th year.

AT THE Engineering and Scientific Club, Wolverhampton, recently, Mr. F. H. Rosencrants gave a lecture on the development of powdered fuel in America and this country for the purpose of the generation of steam for power purposes.

A Useful Red Lead Pump.

BY "VALLISHE."

Considering the length of time that red lead has been known as a jointing material, one would imagine that the "acme of perfection," so to speak, in regard to its application had been reached long ago. But this is not so. In fact, it is practically beyond dispute to say that no progress has been made in this matter during the last one hundred years at least. A sweeping statement maybe, but none the less true. Let us take an example which bears out the truth of this statement. Watch a pipe erector at work making joints. The red lead is spread on to the flange by any handy tool which happens to be in the vicinity. Much of it is wasted, for what is scraped off the flange as surplus is more generally thrown at one side than otherwise.

In this article the writer introduces a hand pump specially designed for the purpose of spreading red lead on to pipe flanges, etc., without waste and uncleanliness, and also saving considerable time on big jobs. No doubt there will be some people who would still prefer the old method, whatever else was introduced. Nevertheless, one hopes that these are a small minority.

The entire pump is made of metal, with the exception of plunger leather, no wood whatever being used. This is of course necessary, as the pump is sure to receive rough usage. The body A is of steel, being 2½ in. diameter inside by 10 in. long. Both ends of the tube are screwed outside

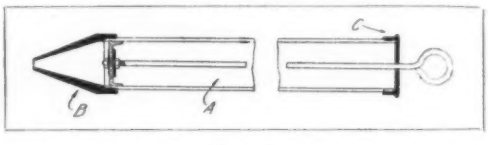

FIG. 1.

to a distance of ¾ in. from the ends. The feeding end B is of brass, being tapped to screw on end of tubing. This portion B is screwed on to tube until it comes against shoulder provided on B, and is locked.

Care must be taken to make the above casting of ample strength, especially the taper end, which, if made too long and thin, is liable to be broken off with the accustomed rough handling. The opposite end of the tube is provided with a cover C screwed on to the tube and shouldered similar to end B. This cover need be of only very light design. A ⅞ in. dia. hole is drilled through the centre, through which the plunger rod passes, allowing working clearance. The plunger rod is of ½-in. dia. steel, and is shaped at one end, as shown, and screwed at the other end.

A cup leather forms the plunger; this should be a good fit in the tube body. At each side of the leather is a disc—a thin one, about ⅛ in. thick, against the working face, and one about ¼ in. thick on the other side. The whole is made a unit by means of a nut at each side, as shown in illustration. Care should be exercised in fitting these together, and the nuts should be screwed up tight on each side, so that they cannot come loose. A good coat of paint is all that is now required, and as a matter of finish this should be done. To fill the pump, unscrew the end cover, and remove the plunger and rod; load with lead about ⅞ full, and insert the plunger and replace the cover again.

The pump should be emptied and cleaned at the end of a day's work, as the red lead is apt to harden and make up outlet hole at end of pump. Never use the pump unless the end cover is in place, or the plunger will soon wear away through lack of central support.

Melting Babbitt Metal. — When melting Babbitt metal always heat it very slowly. In order to prevent the oxidation of the tin and antimony, cover the surface of the melting metal with fine powdered charcoal, and stir with a stick made of dry pine. This stick serves as a guide to the correct temperature of the Babbitt, since the molten metal must not become so hot as to char the pine.

Practical Points from Published Papers.—III.

By B. ROGERS.

The general trend of the two previous articles* has been towards pointing out to foundrymen certain lines of thought that the writer considered important, in the progress towards the successful production of high-grade cast iron. Total carbon, as controlled by silicon, was stated to be the main factor in the production of cast iron by the use of low phosphoric irons. Beeny's conclusion is again worth quoting. "From a practical point of view the best results are obtained with the *lowest possible silicon and total carbon contents* that can be safely depended upon to give a non-chilling effect in the smallest important section of a casting." Semi-steel was preferred to hematite iron for low phosphorus cast irons. Phosphorus influences total carbon in phosphoric pig-iron. (It may reasonably do so in cupola melted cast irons. In fact it would be surprising if it did not.) High-phosphorus is still necessary for thin castings. The writer is aware, however, of semi-steel being successfully used in castings in America for sections of $\frac{1}{8}$ in. and over and often production figures reach a high rate on certain sections.

The size of the graphite flakes was shown to have a distinct relation to the hardness of the casting.

To obtain a proper control over silicon and sulphur, laboratory control is the best course, whilst the use of a microscope will help materially in locating the causes of defective castings. Whenever sulphur trouble is experienced it may, however, be confirmed by the use of sulphur prints.

Sulphur Prints.

By polishing a surface of the specimen of iron and placing a smooth surface bromide printing paper over the specimen, already soaked in a little very dilute acid (3 per cent. sulphuric acid (Conc.) in water), the sulphur spots will produce a dark stain on the printing paper wherever they exist. It is due to the escape of sulphuretted hydrogen, liberated by the dilute acid, forming a sulphide on the bromide paper. The print is well washed and fixed in ordinary hypo. solution. Manganese sulphide gives brown stains as a distinctive colour from merely dark stains. This method was devised by Baumann, and may be used for pig-iron fractures, cast iron, malleable iron or steel.

The Influence of Silicon upon Carbon in Cast Iron.

Turner's classical experiments are the recognised basis for the use of silicon in the manufacture of cast iron. He found with iron of approximately 2 per cent. silicon, by adding silicon in increasing proportions and observing the effect of each addition, that the combined carbon content decreased with increasing silicon; generally, the graphitic carbon content increased with increasing silicon content. The total carbon varied from 1.50 to 2.61. It is noteworthy that the total carbon was more constant (1.9 to 2.35 per cent. T.C.), while the silicon was below 2.5 per cent. The manganese in the higher silicon alloys (above 2.5 per cent. silicon) was also higher than in the lower silicon alloys. The extreme variations of from 1.5 per cent. to 2.61 per cent. silicon in the last five alloys of the series may possibly be explained partially by what Hatfield describes as "the difficulty of melting very siliceous irons to contain about 2 per cent. carbon."

The sulphur and phosphorus were not high and did not vary greatly. Turner says: 'Bear in mind in drawing deductions that the results are for certain definite conditions." Also: "The results, however, are approximately true [as found by practical experience] for other conditions."

Hatfield insists that "the influence of silicon is modified by the size of the casting, the rate of cooling and the casting temperature. The size of the casting is the main point." If the silicon is correctly chosen to suit the section of the casting, the rate of cooling will be controlled by the section or mass, provided the casting temperature is kept constant, and the remaining composition being the same.

Hamasumi's Experiments.

The influence of silicon upon cast iron was also recently demonstrated experimentally by Hamasumi. He used steel mixed with the cast iron. He kept the total carbon constant at 3.0 per cent., using green-sand moulds. He found that with 0.15 per cent. silicon the specimen was not sound, and that the ordinary cooling rate of a green sand mould is such that with 3 per cent. total carbon and 2 per cent. silicon the best graphite-in-whirl structure is obtained. The influence of silicon upon carbon was modified by the rate of cooling.

Whenever the cooling rate of the green-sand mould was too slow, elements were added such as nickel and manganese and sulphur. He concludes: "This has the effect of improving the form of graphite. It does so by altering the cooling rate of the iron. This, again, will affect the condition of the graphitic carbon in the cast iron." A brief statement on the point is essential.

Whirling Graphite.

Hamasumi says "the graphite-whirl form of graphite is the best because it has a moderate strength, and its structure is very homogeneous throughout the whole casting. A condition which is most advantageous when making a large casting of varied thicknesses. In addition to a certain increment of combined carbon this whirling graphite is a condition that strengthens cast iron. It is *caused by the rate of cooling of the casting* and is *to some extent independent of the composition of the iron used.* Graphite-in-whirl is coarser than the wormlike graphite found in the eutectic areas. The worm-like graphite, the graphite-in-whirl and also the usual platy graphite are all adjustable by the rate of cooling."

Hamasumi used a Swedish charcoal pig-iron with mild steel and ferro-silicon added and they were melted together in a crucible furnace. The total carbon content was always 3 per cent. in green-sand moulds. The eutectic concentration of silicon for 3 per cent. T.C. is 3.4 per cent. Si, Hurakami states. Alloys containing 0.64 per cent. silicon to 1.8 per cent silicon were the strongest, the tensile and brinell figures being practically constant. After 1.8 per cent. Si the strength and also the Brinell Hardness number diminished up to 3 per cent. silicon. The combined carbon gradually decreased with increasing silicon, and the graphitic carbon increased with increasing silicon. The tensile strength was 18.3 (0.64 per cent. silicon) to 19.1 tons per sq. in. (1.8 per cent. Si). The hardness figures (Brinell) were 185 to 192 with 0.64 per cent. silicon and 1.8 per cent. silicon respectively. Other silicon percentages (intermediate) gave intermediate results on both tests.

Influence of Silicon upon the Combined Carbon.

Bearing in mind the above experiments that the total carbon is constant throughout at 3 per cent. T.C., the influence of silicon may be seen to be a somewhat gradual one thus:—

TABLE II.—(*Rearranged*) (*Hamasumi*). *Using Green-Sand Moulds. Casting Temperature* 1,350 *deg. C.*

Si. per cent.	C. C. per cent.	Remarks.
0.15	2.87	Unsound
0.64	1.13	
0.70	1.05	Strongest
1.15	0.90	
1.24	0.85	Castings
1.80	0.73	
2.27	0.63	Fairly strong Not so hard
2.76	0.18	Hardness is low

The Ratio of the Silicon to the Combined Carbon.

In the production of all pearlitic cast iron, it is essential to have a certain proportion of combined carbon present in the iron. This may be from 0.55 to 1.15 per cent., depending largely upon the conditions of casting and composition.

* F.T.J., March 19 and July 23, 1925. Cast Iron and Influence of Various Elements (Hamasumi); F.T.J., June 19, 1924. Formation of Graphite in Cast Iron (Northcott).

XUM

How is it to be known whether there is sufficient combined carbon present to form a wholly pearlitic structure? It depends upon composition, usually upon the silicon, the manganese and the sulphur and the phosphorus, the rate of cooling, the casting temperature and the section of the casting.

Obviously some of these conditions must be standardised before any success will be obtained. If, as in certain of Hamasumi's experiments, the composition is kept constant (and especially the silicon is kept constant at 1.8 per cent.), while the section is kept constant (as in the test-piece section), and the casting temperature kept at 1,350 deg. C., success would be soon assured. Silicon can be kept constant, also, possibly casting temperature (but that only by pyrometric control coupled with diligent attention to the cupola metal); still, the section of the casting is limited to the one thickness unless means are used to overcome this difficulty.

When means can be adopted to overcome this difficulty, by heating the moulds and choosing a composition that suits, such as in the Lanz process, success is assured to a certain degree. The above probably represents the Lanz method of production for certain classes of castings. Otherwise the air-furnace or the electric furnace have many advantages over the cupola. Semi-steel will, however, help greatly in cast iron manufacture by the cupola if properly melted.

The old empirical rule Si + T.C. = 4.5 is very helpful. It, however, refers to the maximum amount of silicon that can be used.

With regard to lesser quantities of silicon than are obtained by this method, little is known by the average foundryman, being a matter for research. By way of showing the relation between the combined carbon and the silicon in Hamasumi's experiment as in Table II, the following Table III is appended.

Take No. 1 iron in Table II. There exists in the iron 19 times the amount of the combined carbon by percentage analyses to the percentage analysis of the silicon. The writer does not imply the existence of a *definite* ratio between the amounts of these separate elements. It is because these figures are gradually decreasing in themselves that the writer thinks it might be of value, as distinct from two variant elements as in Table II (Si and Total C.).

TABLE III.

In No. 1 Iron (Table II.) there was			19.0	times the amount of C.C. to Si. (percentages).	
In No. 2	do.	do.	1.76	do.	do.
In No. 3	do.	do.	1.5	do.	do.
In No. 4	do.	do.	0.78	do.	do.
In No. 5	do.	do.	0.69	do.	do.
In No. 6	do.	do.	0.40	do.	do.
In No. 7	do.	do.	0.27	do.	do.
In No. 8	do.	do.	0.06	do.	do.

Hamasumi states that "No sound specimen was obtained with green-sand moulds while no graphite showed under the microscope." He accordingly cast No. 1 test bar in an iron mould.

Further Experiments by Hamasumi.

In another series of experiments Hamasumi varied the total carbon content and kept the silicon percentage constant.

TABLE IV.—(*Hamasumi*). *Giving only the Strong Irons. The Irons below .58 C. Carbon were all Weak. Casting Temperatures* 1,350 *deg. C.*

Si. per cent.	T. C. per cent.	C. C. per cent.
1.87	3.07	0.58
1.96	2.45	0.70
1.79	2.33	0.73
1.94	1.75	0.80
1.86	1.84	0.86

In these experiments, as the silicon percentage is kept constant, and the total carbon percentage is varied, the combined carbon percentage is seen to vary somewhat proportionately to the total carbon content.

It is evident that under the conditions obtaining for Table II of Hamasumi's experiments that the low total carbon with the approximately constant silicon percentage gave good results. This particular constant silicon figure was found by Hamasumi (by experiments) to be the most promising silicon figure for his experiments on green-sand work. It agrees with Turner's figure, viz., 1.8 per cent. silicon, giving the maximum strength by the tensile test.

The Detroit Congress.

At the December meeting of the Philadelphia Foundrymen's Association, Mr. Stanley G. Flagg, a Past-President of the American Foundrymen's Association, brought up the question of entertaining the European foundrymen who are scheduled to stay two days in Philadelphia. A committee was formed and promises were received to throw open the plants of the Baldwin Locomotive Works, the Westinghouse Electric and Manufacturing Company, and the Edward G. Budd Manufacturing Company.

In connection with the Detroit Congress, the "Iron Age" announces that there is to be a symposium on permanent and long life mould castings. This phase of foundry practice which has assumed such importance in the past few years will be thoroughly discussed at the meeting, the discussion being planned to cover non-ferrous, iron and steel practice, and to be international in scope.

The Cothias and similar processes used in England and France will be explained. The American practice developed in using oil-cooled moulds for pistons, the process of using zinc-impregnated moulds and the many other special developments in the field will be considered.

The committee organising this symposium, under the direction of Jesse L. Jones, metallurgist, Westinghouse Electric & Manufacturing Company, East Pittsburgh, will welcome information from any one who has been instrumental in developing or carrying on work in this field of casting procedure.

British Brass Industry.

Mr. Oscar F. Brown, the American Vice-Consul in Birmingham, according to the "Iron Age," is responsible for the statement that the British brass industry has been continuously declining since 1914.

This has been particularly the case in regard to the export trade, which in 1914 formed more than one-third of the total output, but has now sunk to less than one-sixth, it is said, because of the general decline in trade and the increased effectiveness of foreign competition. Domestic consumption has also declined somewhat on account of the general economic depression and more particularly because of the depression in the building trades, engineering and shipbuilding.

It has been estimated that the total output in the brass industry is about 20 per cent. less than before the war, while profits have greatly decreased from the necessity of meeting foreign competition.

There is now, however, an inclination among those interested in the industry to believe that in the future conditions will improve gradually.

Foundry Query.

Blast Pipes.

I wish to obtain some reliable information regarding the advantage or otherwise of that method of introducing blast to the cupola in which a *single* blast pipe enters the windbelt *tangentially*.

I should be extremely obliged if you could supply me with any data, or put me in touch with some foundry which uses this method.—H. W. G. H.

To Clean Dirty or Greasy Waste.—Fill a suitable tank with water and add soda and cheap soap or some other washing compound. See that the whole is properly mixed, and then throw the dirty waste into this solution. Boil for several hours by exhaust steam entering the tank through a suitably arranged pipe.

Some Metallurgical Points in Electric Steel Castings and Notes on Defects.

By F. A. Melmoth (Mappin Medallist).

The normal metallurgical procedure in the production of electric steels has been dealt with quite fully in many Papers submitted to members, and needs no further discussion at the moment. The writer feels, however, that there must be many users of electric furnaces, who, like himself, are occasionally thrown into contact with cases of abnormal behaviour—occasions when the usual metallurgical explanations fail to meet the case, and where known and demonstrated facts offer no acceptable elucidation of the trouble. With a view principally to stimulating discussion, the present Paper attempts to deal with one or two of these questions, and offers tentative theories, none of which is given with any degree of dogmatism.

Fluidity.

In previous Papers dealing with steel castings the writer has mentioned briefly the matter of the comparative fluidity of these steels. He has suggested that fluidity may not be a direct function of temperature and orthodox composition. The well-known difference in fluidity, or "life" as it is often called, existing between electric steels and converter steels of similar composition, has been explained theoretically in several ways. It has been stated in fact that the difference does not exist, and that given temperatures in either type will produce equal fluidity. The writer cannot, however, accept this, and he believes that most practical steel makers who have had the opportunity of working the two processes, side by side, on the same material, will agree that a marked difference does exist.

The suggestion has been put forward in explanation of this, that in the case of the converter metal, its method of production almost ensures the presence of dissolved oxides, which continue to react with the deoxidising elements added, with consequent production of heat during the period of casting. One would expect in this case to find an appreciable loss of such elements during this period, which is not borne out to any serious extent in practice.

As a contrast to this theory there is the possibility of the direct solution of oxygen, or oxides, which by their presence lower the solidification point of the steel, thus giving a longer liquid range and consequently increasing the "life" of the molten metal. The writer prefers to keep an open mind on this question, and would merely state a few observations carried out over a period of some years.

Method of Production.

Electric mild steels can be produced either by the single or double slag process, the choice depending on the quality of the scrap material to hand, or the degree of purity demanded in the product. In the double slag process the melting slag, high in oxides, is removed after melting is complete, and with it the bulk of the original phosphorus content of the charge. A new slag is then made on the metal by the addition of lime, and a small amount of spar, which slag after fusing, is kept decidedly reducing in action by the periodic addition of small quantities of anthracite coal dust or similar material. Such a slag rapidly removes oxidising conditions, and there is little doubt but that the bulk of the oxides are removed thus from the bath of liquid metal. Finishing alloys are added and, given sufficient heat, the material is cast in the ordinary way.

In the single slag process, however, all the operations are carried out under the one slag. This slag contains quite appreciable percentages of oxides, even up to the time of tapping the steel, and strongly reducing conditions are not present.

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. Masters presiding.

It has been the writer's experience that the single slag method of production produces a material more capable of running light sections, and easier to manipulate in hand shanks for small work, owing to its apparent greater degree of fluidity. He would reiterate that differences in composition from the orthodox standpoint are certainly not the reason, and as the difference is noticeable almost consistently over a great number of charges, it is unlikely that variations in temperature should always react in the one direction.

Effect of Strongly Reducing Slags.

It has been the experience of most producers of electric steels using two slags, and strongly reducing conditions, to come up against an occasional charge of an unusually viscous nature. The writer has experienced several such charges, and has been unable to associate the peculiarity with temperature. In conjunction with his colleague Mr. George Batty, Works Manager of the National Steel Foundry, he arranged for a close observation in this works, and the one with which he himself is connected. Electric furnaces of three different makes could by this means be observed, together with converter produced steels of the same general analysis.

The same conditions were found in both works. Certain charges, fortunately of infrequent occurrence, were found to be of such a sluggish nature, although extremely hot, that it was impossible to handle the material in shanks at all.

In order to ascertain whether this was in any way due to the strongly reducing conditions, steps were taken to remove promptly such conditions on each occasion that a charge behaved in this manner. By the addition of a small quantity of iron ore to the slag, or of rusty steel scrap to the bath, the slag was made slightly oxidising. The viscous condition was removed, and there is no doubt in the writer's opinion, therefore, that this sluggish condition is in some way connected with the strongly reducing conditions of the double slag process.

A point strongly noticeable about such charges when being cast was that in appearance they were very much hotter than converter metal of similar composition. They were glowing white, and invariably set over in a skin on the surface of the metal immediately it was in the shank. This lead to the consideration of the possibility that the condition was one in which the material had the peculiarity of dissipating large amounts of its heat energy in the form of light. A singular point bearing on this, is that many of these charges could be satisfactorily cast from the bottom pouring ladle direct into the moulds although skimming over immediately if they exposed any appreciable surface, such as in a hand shank.

Mr. Victor Stobie's contribution to the discussion on the writer's Paper given at the Manchester Conference two years ago contained a striking point which can be taken as some confirmation of the above suggestion. In order to fill up some feeder heads, Mr. Stobie took wild highly oxidised electric furnace metal which had been subjected to no reducing slags. Ferro-silicon, etc., was added to quieten it, and much to Mr. Stobie's surprise the material ran perfectly and left the ladle quite clean. The interesting point in view of the writer's present remarks is that Mr. Stobie remarked on the *cold appearance* of the material as it was cast, in fact, the writer believes he likened it in colour to cast iron.

Effect of High Temperature and High Silicon Combined.

A second very uncomfortable type of happening which is also fortunately infrequent, is that of a charge which is hot and wild, and cannot be quietened by ferro-silicon additions except in

very unusual quantities. Several of these have come under the writer's personal notice, and in almost every case, although a final sample taken from the furnace has been dead and apparently quite in order, the steel has risen badly in the moulds, and any castings made have been scrapped.

Returning the remaining liquid steel to the furnace and treating it for a further period under a reducing lime slag, although resulting in a sound furnace sample exactly as before, was only followed by the same result. If the steel were allowed to solidify, and the resulting metal then remelted and dealt with normally, no trouble was experienced. The most surprising fact was that silicon was invariably very high, often from 0.7 to 0.9 per cent., and the material hot.

Careful observation revealed that in most cases, either owing to poor bricks, or careless workmanship in control of the furnace, the roof and walls has been badly run, and the slag become consequently somewhat siliceous. Additions of ground anthracite coal to the slag obviously accounted for the high silicon content by the reduction of the silicon so obtained from the slag; but, why did the steel rise, and why was it necessary completely to solidify it and remelt before it could be made sound? Also, why were the furnace samples sound before tapping?

With all reserve, the writer suggests that in some manner, probably related to the silicon content, the steel possessed a greatly increased capacity for absorbing gases, and retaining them only in the fluid condition. These gases were thrown out of solution during solidification, and caused the steel to rise. The samples from the furnace taken in a slag-covered spoon were not subjected to the mould gases, and were therefore sound. The evidence still suggests, however, that it is possible the condition of the silicon content was different from that of a normal steel, and a little thought will show that quite a moderate form of the same trouble might account for many of the cases all steel founders come across, of apparently inexplicable unsoundness. There are undoubtedly many such cases, as where analysis is apparently correct, mould and cores in every way identical as nearly as is humanly possible, and yet there is the occurrence of most aggravating patches of trouble from unsoundness.

Contraction: Effect of Process.

A point of unusual interest is that of contraction when considered in the light of the above points. The normal contraction allowance for mild steels of the converter type is $\frac{5}{16}$ in. to the foot. For electric furnace steels, of the double slag type, which have been subjected to what the writer would call "over reducing" conditions, the common allowance is $\frac{1}{4}$ in. to the foot. As these steels are of practically the same composition, the question at once arises why should their degree of linear contraction vary? The writer can offer not the slightest feasible suggestion on the point, but careful measurements being made at the present time in the works with which he is connected, suggest that single slagged electric furnace charges, which have not been "over reduced," have a linear contraction practically identical with converter steels of similar composition. This does not seem to make it reasonable to associate the phenomenon with casting temperature, but it does appear to add substance to the writer's suggestion that steels of identical orthodox composition can behave in different manners, according to the conditions to which it is subjected during manufacture.

Behaviour in the Mould of Steels made by Different Processes.

Carrying the comparison of converter steels and electric steels, or single slagged and double-slagged electric steels, into the realms of practical behaviour in the mould, the writer has found some remarkable impressions in the minds of the moulders handling the various kinds of steels. He is not prepared to explain these away as the results of prejudice, in fact he feels that only the worst form of prejudice can cause one to ignore the intelligent observations of the moulders concerned. The writer is carrying on his efforts to check and prove or disprove many of the ideas put to him by such people, and is not prepared at the moment to offer more than mere comment. He would, however, assure members that even in the present stage of his inquiries he is convinced that the majority of these observations are founded on something more than fancy, and also that they are all in some way interconnected; comparative fluidity, linear contraction, behaviour to mould gases, etc.

It is a common impression that smaller risers are needed to produce soundness in a given section of converter steel than is the case with "over reduced" electric steel. The writer's own experience goes rather to prove this, and in connection with it would mention one point brought to his notice some time ago.

The chemist of the National Steel Foundry, Mr. Windsor, by which the firm the writer was engaged at the time in a consulting capacity, stated most definitely that two tons of electric steel of the "over reduced" kind, occupied more ladle space than an equivalent weight of converter steel. As, in the solid form, the two steels are almost identical in weight for a given bulk, the writer would like to know whether this can be in any way interpreted as a reason for first the excessive contraction of such over reduced material, and secondly for the moulders' contention that such material requires larger feeding heads.

Absorption of Mould Gases.

Susceptibility to the effects of mould gases is another charge laid by the practical man against the "over reduced" electric steel. Regarding this, the writer asserts most emphatically that the most difficult steel in his experience from which to make a really sound casting is one which has been subjected for a too prolonged period to strongly reducing conditions. No obvious explanation occurs to the writer for such behaviour, but he would quite tentatively suggest the following as a theory which at any rate supplies a point for discussion, however incorrect it may ultimately be proved to be. In the molten superheated-condition, all these mild steels must possess a capacity for gas solution. This solution may be of temporary nature, the gases being evolved on solidification, or it may quite possibly be that in some cases the solution is permanent, and the gases are held in solution even in the solid condition. Is it possible that steels made in the conditions existing in the converter have used up their available capacity, in other words, are they in some fashion, saturated? And, is the material with which they are saturated, capable of being held in solution through solidification?

An affirmative reply to these questions would suggest that on coming into contact with mould gases, such steels, being incapable of taking them into solution, will drive them forward and merely displace them without absorption.

The atmosphere in which electric steels are made is very different, however; in fact, great claims are made for these furnaces on account of their atmosphere and degasifying conditions. Then, is it not conceivable to suppose that such steels arrive in the mould with a great capacity for absorbing, unfortunately often in an only temporary manner, large quantities of such gases as they encounter during pouring?

The writer feels that such a theory is difficult to substantiate by actual proof, but he believed that this temporary absorption of mould gases and their liberation on solidification is at the bottom of many steel foundry troubles. Many foundries add small quantities of aluminium actually to the stream of metal as the mould is being cast, and some founders state most emphatically that added thus it is much more effective in promoting soundness than when added to the ladle during pouring from the furnace. The writer is definitely inclined to agree with this, and would suggest that this belief might possibly be taken to have some connection with the theories above mentioned, on absorption of mould gases. Aluminium is believed to possess the capability not only of removing dissolved oxides but of conferring upon steel the capability of retaining gases in solid solution. If, therefore, it be added almost at the precise moment at which the steel absorbs such gases, and is actually present in the metallic form, it appears probable that such action will then take place with the greatest efficiency.

The writer holds that aluminium added to rising steel in an endeavour to make it sound when cast is grossly bad practice, and the steel suffers in consequence, but he believes that small quantities added to well made, and deoxidised steels, tend to confer on the steel the capacity of dealing more satisfactorily with any gases with which the steel may come into contact during casting.

The foregoing would suggest that in order to obtain the most satisfactory results, silicon content should be no higher than is called for to ensure initial soundness in the steel, whilst it would be of benefit to keep manganese on the high side, say, from 0.7 to 0.9 per cent. This is found to be in accordance with actual practice. A high silicon, particularly if thin sections, calling for abnormally high temperature, are the order of the day, does not favour the production of sound castings but rather the reverse.

The metallurgical consideration of electric steel castings is closely bound to the question of sands, in fact, it is extremely difficult to deal usefully with one without the other. The writer would emphasise that it is not by any means a difficult matter to make perfectly sound mild steels electrically. To produce from such steel perfectly sound sand castings is altogether another question. Every practical foundry man attaches due importance to the effects of sand, variations in its physical and chemical condition, its moisture, and the degree of ramming to which it is subjected. He takes it as an accepted fact that all these points can materially affect the successful production of a casting, even given well-made metal.

Suggested Research.

Whilst realising this, it appears to the writer that the line of progress from the purely metallurgical side, is in the direction of the study of mould effects upon liquid metal, and the subsequent attempt to produce steels less affected by such actions. Accepting the fact that highly superheated steels may and probably do, dissolve large amounts of gas when cast, then fairly obviously a profitable line of investigation exists in two directions. The first, can any conditions be induced in the steel in which it shows this solvent action to a lessened degree, and second, can the steel's chemical constitution be made of such a type as to favour the permanent solution of these gases in the solidified condition?

Assuming there to be any foundation of fact in the suggestions previously made in this paper, then the assumption would be that the first condition is affected by the silicon content. In other words, excess silicon with high temperature, has a tendency to increase the temporary solution of gases, and their partial evolution on solidification. The second condition, again assuming the general accuracy of the observations, would be affected by both aluminium and manganese, each of which appear to favour the retention of dissolved gases in the solidified metal.

DEFECTS IN STEEL CASTINGS.

In a Paper of this type, it would appear that only defects of a metallurgical kind should be dealt with, but as previously stated, defects due to metal and defects due to other factors affecting the metal are too closely related to be usefully discussed separately.

Porosity.

The most common defect is porosity, and this may be of several kinds. When directly attributable to metal, it is due to an oxidised condition of the steel, and denotes incorrect furnace manipulation. Fortunately, analysis will almost always explain the trouble, and no ambiguity exists in allocating the blame.

There are, however, many cases of porosity, or sponginess, which cannot be so easily dealt with. The association of porosity with the condition of the metal as handed to the moulder, in all cases, is not unknown to the writer, and whilst this constitutes a very convenient attitude for the moulder, it ignores some of the most important factors in the production of steel castings. Badly-vented moulds or cores, a more or less impermeable sand, an excess of moisture, or the existence of steam in a partially dried alleged *dry* mould, can all cause sponginess, sometimes locally in the casting, and sometimes general.

In connection with porosity an interesting point is the consideration of the comparative liability of steels made by different processes, to this defect.

Contributing to the discussion on Mr. Bradley's Paper on Light Steel Castings given at the Birmingham Conference a few years ago, Mr. D. Wilkinson, whose experience of light steel castings is extensive, emphasised the necessity for the highest attainable temperature of casting to ensure soundness. Mr. Wilkinson is, of course, at present producing his metal by the converter process. The writer having some experience of this metal is inclined to agree, but does not consider it advisable to classify this and the behaviour of electrically-produced steel in the same category.

It does most certainly appear that porosity is a decided possibility in electric steel, cast into sand moulds, as a direct outcome of too high a casting temperature. Many cases of abnormally-hot charges showing porosity in the first castings made, whilst the metal was at its hottest, have come to the writer's notice. Analyses was identical in both porous and sound castings, the only difference being that the sound castings were poured from metal which had lost its first extreme heat. Close observation has confirmed the opinion that whilst hot metal is an absolute necessity, yet a point exists beyond which the liability to unsoundness is markedly increased. If the suggestions made earlier in this Paper can be applied, an explanation is forthcoming. The gas solubility capacity of the steel, and the writer refers to temporary solubility, is increased by the high degree of superheat, with the consequence that quantities of gases, in solution at high temperatures, are thrown out on approaching solidification, with consequent unsoundness in the casting. The suggestion previously made that converter-produced steels have a less available gas-dissolving capacity would offer an explanation of the difference in behaviour of the steels referred to by Mr. Wilkinson, and those being now discussed.

Another possible cause of porosity which is intimately connected with steel production is possible slag action in the ladle. Should the slag be allowed to become in any degree oxidizing just before pouring, its churning up with the steel during pouring from the furnace is liable to produce reaction between its contained iron oxide and the deoxidizing elements of the steel. This may result in their being reduced to a point at which they are incapable of ensuring soundness, and porosity in the castings will result.

Obviously in cases definitely associated with faults in the metal, such as have been mentioned, evidence exists which allocates the blame comparatively easily. Analysis, where silicon is too low for safety, prevents any possible argument. In the latter case, where slag action in the ladle is involved, an inspection of the slag will immediately suggest the cause of the trouble. Even in the case of an excessive temperature of casting, the fact that only the first castings poured are affected, tends to the assumption that excessive temperature has been the culprit. It is therefore an easier matter to deal with such cases of porosity than others which may be due to one or more of a number of reasons connected with the mould itself. Defective venting, wet sand, close impermeable moulds due to too fine a grade of sand, or an excessive amount of a clayey bond, are all serious contributive factors to porosity. In almost all cases where castings suffer from porosity directly due to metal, such porosity is general, and all castings from the particular charge are affected. Odd cases of porosity or local porosity in a casting are naturally much more likely to come under the category of moulding defects than metallurgical manipulation.

Contraction Cracks.

Unless special precautions are taken in the mould, mild steel castings, particularly if of a fragile light-sectioned nature, are very liable to crack on cooling. Metallurgical error can undoubtedly contribute to this.

Mild steels, high in sulphur, are notably tender when cooling from the liquid condition. To

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some extent this can be counteracted by working with a fairly high manganese content. By the formation of manganese sulphide in such a manner, which exists as minute dots throughout the steel, the alternative formation of iron sulphide is prevented. Iron sulphide having a low fusion point, exists between the iron crystals in a more or less filmy form, thus partially destroying their cohesion. After the crystals are formed and the material solidified, such sulphide can still remain fluid, causing the material to be excessively weak at a red heat, and to offer little resistance to the strains to which it is subjected during cooling and contraction.

Here again, analysis point out the cause, which should never be existent in basic electric steel. One of the most valuable properties of the basic electric furnace is its ability to produce with ease very low-sulphur material.

Badly made steel, tapped in a rising condition, is sometimes corrected and made apparently sound by overdoses of aluminium. The writer has previously condemned this as very bad practice, but would add that such material is also very liable to crack in the castings. This is no doubt due to the inclusion of quantities of non-metallic material, such as alumina.

Given a good steel, and normally careful methods of moulding to prevent cracks, the writer is of the opinion that faulty designing is responsible for more trouble with cracked castings than any other cause. Designs are often submitted to the steel founder which have been evolved quite obviously with only one object in view, namely, to fit into the place desired by the designer. The writer believes most strongly that a short course of steel foundry instruction should be a component part of the training of all designers engaged on parts for production as steel castings. Indiscriminate variation of section, the existence of large bosses demanded solid on otherwise thin sectioned castings, are often a perfect bugbear to the steel foundryman, and his failure to give satisfaction is no doubt attributed to his ignorance. Whilst intelligence properly applied when making the moulds will assist materially in preventing such cracks, no skill of the moulder will reverse the natural laws governing the solidification and cooling of steel. Its comparatively high degree of contraction, its high melting-point, and weakness at high temperatures are all definite laws over which the founder can exert no control. He can only take all possible precautions to prevent their causing an excessive degree of trouble. In the writer's opinion such points should also receive the careful consideration of the designer. Granting the engineering demand as regards general design, he should as far as possible bear in mind the following points:—(*a*) Section of metal should be as even as practicable; (*b*) sharp changes of section and sharp corners avoided wherever possible; and (*c*) the minimum number of heavy bosses, which latter should be cored out if in an inaccessible position for feeding, a state of affairs which often exists. A consideration of these simple points would most decidedly minimise the tendency to crack exhibited by many castings, particularly of the automobile type.

Contraction Cavities or "Draws."

The liquid contraction of steel being considerable, steel castings are somewhat prone to this trouble. Heavy risers are often necessary, and careful attention to their point of application and shape is one of the vital points in the production of sound castings. Design will not always permit of correct methods being applied, and here again the consideration of the designer is called for. In order to mitigate the ill-effects of contraction where feeding is rendered difficult by design, various methods are resorted to. The insertion of nails, the application of internal and external chills are common methods applied.

Although these methods are often successful in degree, it must be admitted, however, that they carry with them the possibility of introducing other troubles. Design of chills and their comparative thickness must be carefully studied in relation to the job being made, or very often the latter state of the casting is worse than its first. External chills, for instance, if too severe in their effect, are very liable to cause serious cracks. The object of chills being to induce comparatively even temperature conditions throughout a cooling casting by the abstraction of heat from the thicker portions, it follows that an excessive chill effect will defeat this object, and merely remove the position of the trouble from one part of the casting to another. Soundness may be improved from the drawing standpoint, but cracking troubles encouraged.

Internal chills, say in heavy bosses, are very useful to the steel foundryman when design will not permit of satisfactory feeding arrangements, but here again great caution is necessary if trouble is not to result. In green-sand moulds moisture is very apt to deposit itself on chills or nails, and if moulds are left closed too long before casting almost certain blowing can be expected.

It has appeared to the writer that many defects described by the practical moulder as draws are in fact blows, or in some cases a combination of the two. Some years of observation have convinced him that could gas occlusion, caused either by blowing in its many forms or by the turbulence of the steel during the pouring operation, be entirely prevented, much of the trouble attributed to "drawing" would not be present. This will be considered further in the next section of the Paper referring to blown castings.

Blown Castings.

This defect will be considered as altogether a separate one from blowholes, which previously have been discussed under the heading of porosity. Whereas the former occur as numerous small holes either general or in some local part, the type now being dealt with generally exhibits itself as a large cavity, existing in one or more parts of a casting.

In almost all cases it can definitely be assigned a cause without difficulty. Ineffective or non-existent venting of cores or moulds, the use of wet or dirty chills, are the usual causes. Design in this instance can once again contribute materially. Comparatively small, deep recesses in the vicinity of heavy sections of metal will almost without fail cause a blow, which will usually pass into the heavy section. Very often this can be seen immediately the casting is cleaned, as the hole caused by the blow comes right to the surface, but often the metal closes behind the gases penetrating the steel, and the hole caused is not discovered until machining operations are well advanced.

Pneulec Company's Extensions.

We understand that the constructional plant of Thwaites Brothers, Limited, Bradford, has been purchased by the Pneulec Machine Company, Limited, of Smethwick. This latter firm, having recently entered the equipment side of the industry now vacated by Thwaites Brothers, considerable extensions to the works at Smethwick are at present being carried out, and the plant is being transferred there.

Cupolas, stagings, charging machines, ladles, and all general foundry plant is added to the already well-known line of Pneulec manufactures, which include moulding machines, core oils, oilsand mixers, etc.

The above plant is an accumulation of many years' experience, and the Pneulec Company consider themselves fortunate in obtaining it, at a time when they are launching out in their new sphere of activities.

Another point of interest is that several members of the disbanded staff of Thwaites Brothers have joined the Pneulec concern, materially adding to the service they can be expected to give.

Amounts of Paint Necessary.—1 lb. of mixed red lead paint will cover about 5½ yards, superficial, of iron. 1 lb. of oxide of iron mixed paint will cover from 9 to 12 superficial yards of iron. 1 lb. of mixed white lead paint will cover about 1 superficial yard the first coat on Portland cement rendering (say about cement 1 part, sand 3 parts). 2½ pints of good oil varnish will cover 20 superficial yards of iron one coat.

The Influence of Special Elements on Grey Cast Iron.*

By J. W. Donaldson, B.Sc.

The effect of the addition of special elements to grey cast iron has received a fair amount of attention during recent years. This has been due to two causes. First, the attention of foundrymen has been directed to this question by the extensive use of alloy steels on account of their special properties. Second, the ironfounder, in common with other manufacturers, has been called upon to produce castings of complicated design to meet the demands of modern engineering practice. In this Paper an attempt is made to summarise and review the work that has been done and to arrive at some conclusion.

The normal constituents of cast iron are carbon, silicon, sulphur, phosphorus and manganese. Most commercial irons contain traces of other elements such as nickel, chromium, copper, arsenic and titanium, but the amount present is usually so small that the irons cannot be regarded as alloy cast irons. There is sold, however, a commercial pig-iron known as Mayari pig-iron, which contains about 2 per cent. of chromium and 1 per cent. of nickel.

The investigations which have been made on the influence of special elements on cast iron have usually been confined to the influence of small amounts of these elements. This is no doubt due to the high cost of the special elements, together with the difficulties experienced in melting and casting irons containing high percentages of those elements. The elements which have been investigated and which are now considered are manganese, chromium, nickel, chrome-nickel, tungsten, molybdenum, vanadium, copper, tin, aluminium and titanium.

Manganese.

The influence of manganese on grey cast iron has been investigated by Coe, Keep, West, Hamasumi, and the author. As regards the effect of manganese on the strength of cast iron, Keep concludes that it has little influence, while the other investigators show that both the strength and hardness increase with increasing percentages of manganese. As the amount of combined carbon remains practically the same, it has been suggested that the increase in tensile strength of high manganese iron is due to a matrix change, namely, pearlite changing to sorbite. The shrinkage increases with increasing manganese content, and irons containing over 3 per cent. of manganese are difficult to machine unless the silicon is over 2 per cent. The casting properties of those irons, such as fluidity and freedom from gases, are good and sound castings are obtained.

Chromium.

The earliest work on the influence of chromium on cast iron is that of Keep, who experimented on grey cast iron with chromium additions up to 2 per cent. His results show a slight increase in strength up to 1 per cent., then a decrease. The shrinkage was increased when less than 1 per cent. was added. Campion, in a later investigation, found that 1 per cent. of chromium increased the strength and hardness and also the proportion of combined carbon. Hurst states that in a cast iron containing 1 per cent. of silicon an addition of 0.9 per cent. chromium rendered the fracture quite mottled, and 4 per cent. chromium added to an iron containing 1.5 per cent. silicon rendered the fracture perfectly white; and that drastic annealing at 900 deg. to 950 deg. C. failed to produce graphite. He also states that increasing the silicon content tends rapidly to reduce the stability of the carbide. A cast iron containing 3.15 per cent. silicon and 6.94 per cent. chromium gave a Brinell hardness of 460 on a sand-cast bar, and a chill-cast bar could only be filed with difficulty. The same alloy containing 1.46 per cent. silicon was glass-hard and white. The systematic investigations of Smalley with chromium additions to ordinary grey cast iron and cylinder iron showed that with both irons small additions of chromium 0.11 and 0.15 per cent. increased the strength and hardness slightly, while with the larger addition of 0.78 per cent. to the ordinary iron the tensile strength fell. The transverse strength is little affected, and the Brinell hardness increased. A similar addition of chromium to the cylinder-iron produced an increased transverse strength and Brinell hardness, but little change in the tensile strength. Piwowarsky's experiments show that with up to 0.5 per cent. of chromium the strength and shock-resisting properties of cast iron are increased to the extent of about 10 per cent., while the hardness increases from 20 to 25 per cent. The author's investigations carried out on a good cylinder iron with chromium additions of 0.19 per cent. and 0.39 per cent. show an increase of 5 per cent. and 10 per cent. in the strength and 5 per cent. and 11 per cent. in the Brinell hardness respectively. Recent experiments of Hamasumi show that chromium strengthens cast iron from 16.5 to 22.8 tons per sq. in. in an alloy containing 0.4 per cent. of it without materially altering the structure.

Summing up the results of those investigations, it appears to be definitely established that 0.5 per cent. of chromium in the presence of 1 to 2 per cent. of silicon increases the tensile and transverse strengths and the hardness of grey cast iron. This increase in strength is brought about by the chromium preventing the formation of graphite and producing a more stable double carbide of iron and chromium, which crystallises out with the pearlite.

Nickel.

Experiments on the influence of nickel on grey cast iron have been numerous. Keep added metallic nickel up to 0.75 per cent. to a grey machinery iron, and came to the conclusion that no advantage could be expected from small additions of this element. Guillet found that nickel caused precipitation of graphite, pearlite disappeared as the nickel increased, and cementite became more or less acicular in form. Thaler stated that the addition of 1 per cent. of nickel caused the separation of 50 per cent. of the graphite, and with further additions up to 48 per cent. nickel, graphite gradually increased until 85 per cent. of the total carbon existed as such. Hatfield also expressed the opinion that the precipitation of graphite is facilitated by nickel, and by doing so nickel acts as a softener, but is useful in no other direction. Campion found by adding 1 per cent. of nickel to grey cast iron the graphite was increased from 2.54 to 2.77 per cent., also that there was an increase in strength but a decrease in hardness. Smalley's grain-refining experiments show that 0.5 per cent. of nickel have a densening effect on the structure of grey cast iron. Such a quantity, however, does not affect the hardness. The experiments of Piwowarsky confirm the influence of nickel in producing graphitisation. They also show that a moderate nickel content of 0.5 to 1 per cent. improves the mechanical properties of grey cast iron by 20 to 30 per cent. With a higher content up to 2 per cent., owing to too favourable graphitisation, a falling off takes place. This improvement of the properties by nickel is attributed to mixed crystal formation. The author's own experiment of adding 0.75 per cent. of nickel to a cylinder iron produced no increase in either strength or hardness. Generally speaking, the influence of nickel on grey cast iron is to produce no material advantage.

An investigation on the combined effect of chromium and nickel by Piwowarsky showed that certain relative proportions of these elements increased the tensile and transverse strengths, as well as the hardness and compressive strength,

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen, Engineer Lieutenant-Commander L. Jackson presiding.

without diminishing the resistance to shock and deflection. It was also shown that in the presence of chromium, nickel has nothing like such a powerful effect in precipitating graphite as when present alone. The author's experiments with two chrome-nickel irons indicated that adding chromium and nickel in the proportion of 2 to 1 allows of the use of a higher percentage of chromium, although the benefits derived from the increased chromium were more than diminished by the accompanying nickel.

Tungsten.

The influence of tungsten on cast iron was first investigated by Campion, who found that 1 per cent. of tungsten increased the strength but reduced the hardness. He also stated that 1.5 per cent. of tungsten added to a grey iron containing combined carbon 0.65 per cent., graphitic carbon 2.70 per cent., manganese 0.5 per cent., raised the tensile strength from 11.8 to 17.9 tons per sq. in., and in another case the result was 20.8 tons per sq. in. with 1.28 per cent. tungsten against 13.4 tons in the ordinary iron. In Smalley's grain-refining tests, where from 0.1 to 1 per cent. of tungsten was added, only a slight improvement was obtained on ordinary iron. Piwowarsky experiments indicated that 0.5 per cent. of tungsten favourably influenced the mechanical properties of cast iron. In addition to increasing the tensile, transverse and compressive strengths, there is also an increase in the shock-resisting properties. The effect of tungsten on the carbon is to promote feeble graphitisation, the improvement in the mechanical properties being attributed to the formation of mixed crystals of iron and tungsten, giving rise to a new structural constituent of tungsten-ferrite. The addition of 0.2 per cent. of vanadium, in addition to the tungsten, produced no material effects. Adding 0.475 per cent. tungsten to a cylinder iron, the author raised the tensile strength from 16.6 to 17.6 tons per sq. in.

Molybdenum.

The addition of molybdenum to cast iron was first investigated by Campion who found that 1 per cent. of molybdenum increased the strength and reduced the hardness. Smalley's preliminary experiments showed that 0.1 per cent. of molybdenum closed the grain of grey cast iron without appreciably affecting the hardness, and led to further experiments. The addition of 0.15 per cent. of molybdenum to an ordinary grey iron containing 2.0 per cent. silicon, reduced the tensile and compressive strengths and the chilling power, exerted little effect on the Brinell hardness, and increased slightly the transverse strength and deflection. Increasing the quantity to 0.25 per cent. slightly reduced the chilling power, increased the transverse strength and deflection, but did not affect the other properties. In the presence of 0.5 per cent. of molybdenum, apart from the chilling power which is slightly reduced, all the other properties are improved, especially the compressive and transverse strengths. The effect of small quantities of molybdenum was more marked in cylinder iron containing 1.25 per cent. silicon, 0.12 per cent. improving the mechanical properties, but reducing the chilling power. The addition of 0.24 per cent. molybdenum further improved the tensile strength without affecting the hardness, compressive and transverse strengths. In all the irons neither the fluidity nor total shrinkage was affected by the molybdenum additions. Further tests were carried out adding 1.5 per cent. of molybdenum to a special cylinder iron when the tensile, compressive and transverse strengths were increased by 25, 22 and 9 per cent. respectively. On common grey iron 1.5 per cent. of molybdenum exerted a similar all-round improvement although to a lesser extent. As regards the carbon the tendency of molybdenum is to reduce rather than increase the amount of carbide. Machining properties are affected by over 0.5 per cent. molybdenum, the iron becoming exceedingly difficult to cut. Piwowarsky's tests show that molybdenum produces practically the same effect on grey cast iron as does tungsten on a similar iron and confirms those of Smalley with up to 0.5 per cent. molybdenum. A further increase to 1.0 per cent. molybdenum, however, produces no further increase. The addition of 0.2 per cent. vanadium as well as molybdenum does not produce any better results.

Vanadium.

It has been shown that vanadium in small quantity in conjunction with tungsten or molybdenum does not produce any material benefits in grey cast iron. Investigations carried out on the influence of vanadium alone have been extensive, but contradictory results have been obtained. Moldenke's experiments with vanadium additions up to 0.36 per cent. give inconclusive results. Kent Smith showed that with 0.15 per cent. of vanadium there was an improvement in the tensile, transverse and compressive strengths. He states that the principal action of vanadium is as a scavenging agent for removing oxygen and nitrogen. Norris agrees, generally, with Kent Smith's conclusions, and states that vanadium exerts a strong influence in refining the grain, eliminating porosity, and promoting soundness, increased strength, resistance to wear and rigidity. Hatfield's experiments on the heat treatment of white cast iron containing vanadium, show that vanadium tends to maintain the carbon in the combined condition, and to prevent the precipitation of graphite. Campion found that 0.15 per cent. and 0.25 per cent. of vanadium increased the strength but diminished the hardness of cast iron. Smalley's experiments with 0.1 per cent. vanadium additions do not confirm the hardening effect of this element. Unlike the previous investigator, Piwowarsky shows that this element produces the formation of carbide. The effect of vanadium appears only with additions over 0.5 per cent., and then very suddenly, and is most marked in the lower silicon irons. The transverse and compressive strengths increase, also the hardness which is increased to such an extent that the irons can no longer be regarded as commercial irons. The author's own experiment with 0.125 per cent. of vanadium produced a slight increase in tensile and transverse strengths and also in hardness.

Copper.

Investigating the influence of copper on cast iron, Lupin concluded that while the addition of the element was not beneficial, its presence had no detrimental effect. There was a slight graphitisation effect on the carbon and the tensile strength increased from 19 to 22 tons per sq. in. with 4.9 per cent. of copper. Smalley found that the addition of 0.5 per cent. of copper tended slightly to increase the hardness although there was a slight decrease in the combined carbon. Hamasumi found that with copper additions up to 4.0 per cent. there was a steady increase in the tensile strength and Brinell hardness, and the alloys appeared to be tough. As regards the effect on the carbide erratic results were obtained.

Tin.

Guillet investigated the influence of tin on grey cast iron, and found this element to considerably increase the hardness, and that the hardness was maintained at high temperatures. Hamasumi's tests with up to 6 per cent. of tin show that up to 2 per cent. it increases the strength and hardness slightly, but with over 2 per cent. the irons become hard and brittle.

Aluminium.

Investigations by Melland and Waldron show that the influence of aluminium up to 0.5 per cent. on cast iron is similar to that of silicon. The total carbon is reduced, and the graphite precipitated. Addition of aluminium over 0.5 per cent. produced a reversion, the carbide becoming more stable, and it was suggested that this was due to the formation of a double carbide of iron and aluminium. Recent tests by Piwowarsky do not confirm this, additions of aluminium up to 0.8 per cent. producing graphitisation. In the presence of low silicon there is an increase in the transverse strength and shock-resisting properties, but a considerable decrease in the hardness and compressive strength.

Titanium.

Early investigations by Moldenke show that a small addition 0.05 per cent. of this element increases the transverse strength but that larger

additions produce no further advantage. Piwowarsky's recent experiments confirm this, 0.1 per cent. of titanium producing maximum graphitisation.

Heat Treatment of Alloy Cast Irons.

To ascertain how alloy cast iron would behave when subjected to temperatures such as would be experienced in internal combustion engines, a series of heat treatment experiments were carried out by the author. The irons tested were a plain cylinder iron and irons of similar composition containing manganese, chromium, nickel, vanadium, tungsten and chrome-nickel. These alloy irons were selected, as the elements contained in them had produced the most satisfactory results on grey cast iron in its cast condition. It has since been regretted that a molybdenum iron was not included in the series.

The heat-treatment experiments were carried out under three sections:—(1) Prolonged heating tests for 200 hours at 450 deg. C. and 550 deg. C. respectively; (2) elevated temperature tests as cast and after the above prolonged heat treatment; (3) growth tests.

The results obtained from the first series of tests indicated that in all the irons low-temperature heat-treatment decomposed the carbide with a corresponding decrease in the strength and hardness of the material. The increasing of the manganese from 0.97 to 2.43 per cent., or the addition of 0.392 per cent. of chromium or 0.475 per cent. of tungsten had a stabilising effect on the carbide; whereas an addition of 0.746 per cent. of nickel or 0.124 per cent. of vanadium accelerated graphitisation. The chromium produced the most satisfactory result, the manganese and tungsten, while increasing the stability of the carbide over that of the plain iron, did not produce the same stability as the smaller amount of chromium. In the iron containing both chromium and nickel, chromium exerted the predominating influence, the nickel, however, allowing of the introduction of a larger percentage of chromium.

The second series of tests carried out on the plain, the chromium, the tungsten, and the chrome-nickel irons indicated that if either of those irons is subjected to prolonged heat treatment at temperatures ranging from 450 deg. C. to 550 deg. C. the elevated temperature tests obtained in their cast condition cannot be taken as representative. In the cast condition the tendency is for the strength of iron to diminish slightly as the temperature rises and then to increase again with a further rise in temperature, attaining a maximum in the neighbourhood of 400 deg. C., after which the strength rapidly diminished with increasing temperature. After prolonged heat treatment there is a diminution in strength which falls off uniformly and regularly. This decrease in strength is fairly large, showing in the case of the plain iron, when tested at 400 deg. C., decreases of 21 and 27 per cent. after heat treatment at 450 deg. C. and 550 deg. C. respectively, and in the case of the chromium iron decreases of 4 per cent. and 15 per cent. after similar treatment and when tested at the same temperature. The relative increases in tensile strength for the chromium, tungsten and chrome-nickel irons, over the ordinary cylinder iron, when tested at 400 deg. C. after prolonged heat treatment at 450 deg. C., are 32, 13 and 17 per cent. Breaking at 400 deg. C. after a 500 deg. C. treatment the corresponding increases are 38, 30 and 25.5 per cent.

The amount of growth which takes place in all the irons at 550 deg. C., as determined in the third series of experiments, was small when compared with an ordinary foundry iron. In the cylinder iron growth attained a maximum after 10 heatings of 8 hours duration, when the volume increased by 0.13 per cent. The manganese and vanadium irons showed the most growth to take place during the first 10 heatings and then slowly to 25 heatings with a slight tendency to rise; change of volume after 25 heatings amounting to 0.17 per cent. Growth in nickel iron takes place slowly at first but increases with the number of heatings yielding a volume change of 0.25 per cent. after 25 heatings and still increasing. There was little change with the tungsten iron, a maximum of 0.04 per cent. being obtained after 10 heatings. With chromium there was a contraction in place of growth. The contraction takes place slowly for 10 heatings, then more rapidly to 20 heatings, then slowly again to 25 heatings, where the volume has decreased by 0.27 per cent. The chrome-nickel iron did not show contraction, although the chromium content was higher than in the chromium iron, the effect of chromium in producing contraction evidently being prevented by the presence of nickel. The growth attained was a maximum of 0.08 per cent after 20 heatings.

Conclusions.

Considering the various investigations that have been carried out and summing up the results so obtained, one or two definite conclusions may be arrived at.

(1) The special elements which exert the most influence on the properties of grey cast iron are chromium, manganese, tungsten, molybdenum and chrome-nickel. These elements not only improve the properties of cast iron in its cast condition, but in all cases, assuming that the molybdenum behaves similar to tungsten, the stability of the irons are increased under low temperature (450 to 550 deg. C.) conditions. Chromium to the extent of 0.4 per cent. gives better results than slightly larger amounts of tungsten or molybdenum or than 2.5 per cent. of manganese. The last three elements in the proportions stated give somewhat similar results so that it is doubtful if any material advantage would be gained by using the more costly and more difficult alloying tungsten or molybdenum in preference to manganese. The combined effect of chromium and nickel is that the nickel allows of the addition of a larger percentage of chromium although the benefits derived from the increased chromium are more than diminished by the accompanying nickel. Better results would no doubt be obtained by omitting the nickel and increasing the chromium either in the presence of additional silicon or by casting in heated moulds.

(2) Nickel, vanadium, copper, and tin produce slightly better properties in grey cast iron in its cast condition. The first two elements, however, accelerate graphitisation under heat treatment and it is possible a similar result would be produced by copper. The effect of tin on the stability of the carbide under heat treatment has not been investigated, but there are indications that it might have a stabilising effect.

(3) Addition of aluminium or titanium produce no beneficial results, but rather tend to promote rapid graphitisation.

DISCUSSION.

MR. J. SHAW, after congratulating the author on the excellence of the Paper, stated that Mr. Donaldson had put before them such a mass of data from various sources that he (Mr. Shaw) would require some time to read and digest them, before attempting to offer any criticism. He therefore, confined his remarks to Mr. Donaldson's own figures. He was pleased that the author had used as his base material a pig-iron of uniform composition, but one also that contained all the elements in proportions found in a good commercial pig-iron, and that his base was not a washed iron, but one where all effects of ordinary amounts of Si, S, P, C and Mn come into play. The results were such that any foundry with control could duplicate. Taking the table giving additions of Mn, Cr, Ni, one found that the tensile strength simply followed the increase of C.C., and it was open to the construction that if the original iron had had its C.C. increased only similar results would have followed without the alloy additions. If they took the effect of Ni, a recent Paper by Wickenden proved fairly conclusively that small additions of Ni, such as Mr. Donaldson used, were harmful instead of strengthening, if the Si was much above 1 per cent. That the Ni acted simply as silicon in cases where the latter was about 2 per cent and reduced the combined carbon and strength. The same author had also pointed out that the increased hardness due to fairly high percentages of Ni was due to the closer uniform harder sorbite formed, which at the same time machined easier.

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During their experiments on chilled rolls they found that a difference of 4 points in the total carbon content of an iron acted exactly in the same manner as an increase or decrease of 3 points of silicon on the same material, so that in all deductions the difference in total carbon must be taken into account. While they had done a little work on the effect of annealing certain castings at high temperatures, the work under actual service conditions had not been at work long enough to draw clear conclusions. Some dies contained 0.703 per cent. Cr, and 0.445 per cent. Ni were taken up to 950 deg. C., had given good service. The Brinell number was reduced from 512 to 269, yet there was no appearance of graphite. Other rings of this type after being annnealed twice at 950 deg. C., were then taken again up to this temperature and quenched in water. The Brinell number was then 713. Yet these castings were quite strong and not brittle, but, of course, not machinable. A similar ring was placed in a pan with malleable castings, and after five days and nights at 950 deg. C. was allowed to cool in the furnace. There was still little or no appearance of graphite. Quite half a dozen of these rings were tested for growth, but with two heatings to 950 deg. C. for six hours no increase of size was shown. Whether that would continue with further annealing he was not prepared to say.

MR. J. FERDINAND KAYSER said he was very disappointed to notice that the author had expressed his results to three places of decimals, and yet had apparently only made one series of each particular range of composition. It was highly improbable that the analysis was correct to the first place of decimals, and it certainly would not be correct to the second. That might seem a rather startling statement, but after seeing the analysis made by different chemists of repute, on one and the same metal, he (Mr. Kayser) never ventured to express analysis to more than one place of decimals, and then always with considerable mental reservation. He thought that manufacturers of iron castings were far too nervous in adopting alloy additions in order to improve their metal. Roughly speaking, one could say that the addition of 1 per cent. of molybdenum would increase the cost by approximately 7s. 6d. per cwt.; 1 per cent. chromium, 2d. per cwt.; 1 per cent. vanadium, approximately 15s. per cwt. Such increases of prices were, however, by no means just cause for alarm, and, given the results sufficiently high, there was no need for a maker hesitating to put on the market a casting costing five or even ten times as much as a similar casting made from ordinary grey iron. It appeared to be generally agreed that chromium was one of the most beneficial metals that could be added to grey cast iron. Approximately 3 to 4 per cent. of chromium gave, of course, a white iron, and one very easily susceptible to heat treatment. It could be softened suitable for machining, and, if necessary, could then be re-treated and hardened.

An Uncommon Cast Iron.

It did not seem to be known in the cast iron world that for some years now a metal has been on the market containing approximately 3 per cent. of carbon and 14 to 15 per cent. of chromium, together with approximately 0.7 per cent. silicon and the usual other impurities found in hematite iron. That metal could be forged without much difficulty, and could be given any Brinell hardness from approximately 250 up to 600 by a suitable heat treatment.

MR. E. ADAMSON said it occurred to him that there was possibly a difficulty in regard to the open iron and the close iron. They could add manganese to iron, but on melting in the crucible they would get a hardening effect. The effect if manganese was added in the blast furnace would be to open the grain, with resultant higher carbon. That meant that in the open iron they had low combined carbon and higher manganese. The results of practical work were of much interest, as they showed the practical difficulties under which the furnaces worked, and were of more importance than those derived in the laboratory. Many of the results shown that night were not commercial irons, but were laboratory results, and therefore could not be relied upon to give any strict guidance in the foundry. Referring to titanium, the speaker said it was not generally known how useful it could be as a cleanser. This was particularly the case in regard to iron in blast furnaces.

MR. HYDE referred to early experiments which he had with Professor Arnold with pure Swedish iron, and went on to say that one interesting thing he had noticed was that with nickel steel containing 1 per cent. of carbon the nickel threw carbon out in the form of graphite. The nickel behaved almost exactly like silicon.

The Author's Reply.

MR. J. W. DONALDSON, in reply, said that while he agreed with Mr. Shaw that the increase in tensile strength followed the increase in combined carbon which was produced by the manganese, chromium and tungsten additions, he thought that the strengths so obtained were more stable under heat treatment due to the increased stability of the special carbides than would be the case in a plain iron of similar carbon content. With reference to Wickenden's Paper, he had not seen it, but he was pleased to know that the results obtained with nickel were somewhat similar to his own. Mr. Shaw's annealing experiments with chrome-nickel cast-iron dies and rings were of considerable interest. The falling off in hardness after annealing at 950 deg. C. was to be expected, but why that decrease should have taken place without precipitation of graphite he could not understand. The increase in hardness after quenching from 950 deg. C. was also to be expected, being no doubt due to the formation of martensite and troostite. The fact that no growth occurred after heating to 950 deg. C. clearly demonstrated the beneficial effect which chromium had on this property.

In reply to Mr. Kayser's remarks regarding the analysis, he would say that, where three places of decimals were given, these were simply the average of two results determined to two places of decimals and differing by 0.01 per cent. He was glad to hear Mr. Kayser's views regarding the addition of special elements to castings, and especially that he agreed with him (Mr. Donaldson) in the beneficial effects produced by chromium. The fact that an iron containing 3.0 per cent. carbon and 14 to 15 per cent. chromium was on the market was quite new to him, and also that such an iron could be machined, forged, and subjected to heat-treatment. In his own experiments he found that an iron containing 0.9 per cent. chromium, 1.5 per cent. silicon, could not be machined. The iron he referred to was cast in a cold sand mould, and possibly the one mentioned by Mr. Kayser was cast and cooled under different conditions.

Mr. Adamson's remarks regarding the production of iron in the blast furnace were very interesting, particularly with reference to the effect of manganese on the production of close and open irons, and also with regard to the cleansing effect of titanium. With reference to some of the results dealt with in the Paper, they were derived from irons produced in the laboratory, and although they could be used as a comparison among themselves, he agreed that they could not be used as a guidance in foundry practice.

Mr. Hyde had referred to his early experiments with Professor Arnold on irons prepared from pure Swedish iron where only one constituent was varied. He (Mr. Donaldson) knew of experiments in progress at present on irons prepared in a similar manner, where the phosphorus content varied in one series and the chromium content in the other.

LIEUTENANT-COLONEL SIR JOSEPH NALL, M.P., proposed the toast of "The Institution of Mechanical Engineers" at the annual dinner of the North-Western Branch of the Institution in Manchester on December 17. He said he understood that there was still room for development in steam engineering and mechanical engineering, and it was obvious, therefore, that we had not come to the end of that form of power, and should have regard to its possibilities while considering other developments. He would urge that we must endeavour to maintain our perspective. The public should not be undesirably and foolishly coerced into believing that vast grants of State subsidies to one sort of power or a complete system of State control applied to that power was going to be to the benefit of the community as a whole. If assistance was granted to one industry the other was at a disadvantage.

The Selling of Castings.—XXIII.

BY VOYAGEUR.

Sales Letters.

Having discussed the mailing-list, one must now consider the sales letter as a means of selling castings. It must be remarked that, quite apart from the scope and function of the sales letter itself, it should never be sent out alone. It should always be accompanied by some kind of enclosure to heighten the effect, to illustrate the argument, and to reinforce the appeal.

The advantage of sales letters as a form of selling is that they can be turned out quickly, much more quickly than can printed matter, so that by their help a topical event can be turned to good account. To give an instance; a certain official of high standing as the designer for a large firm of world-wide repute declared in an address to a society with which he was connected, that for certain specific parts of a specific machine he had found nothing to equal cast chrome steel. The day after a précis of that speech had appeared, every user of machines of that type found in his morning's post a letter from a firm of steel founders reproducing the extract from the speech in question, and enclosing the firm's catalogue. As a direct result, nearly £5,000 worth of orders were received.

It was not that this founder was the only maker of castings in chrome steel. It was simply that he struck while the iron was hot, and for this purpose he could have chosen no better means than the sales letter.

Usually the essence of this form of selling is duplication. There are a fair number of duplicating-mechanisms from which to choose, and this is not the place in which to discuss their respective virtues. But one thing needs emphasis, that is, to get the maximum result from sales letters, it is necessary to make them resemble as closely as possible a letter individually written and addressed. Of course, it is true that engineers and buyers are no longer so prejudiced against the circular letter as they used to be, and regard it often as a handy means of acquiring information about different commodities. Nevertheless, the personally addressed letter, or the letter that seems to have been written solely to oneself appeals to a naïve egotism in every man, and causes him to pay it more attention. In any event a letter that closely resembles an individually addressed communication compels a second glance in order to make sure whether it is an original or one of many hundreds.

But the object of paying so much attention to the imitation of singly-written letters is not so much to deceive the addressee permanently as to prevent him from throwing the letter away as soon as he opens it.

Sometimes sales letters are sent out without themselves carrying an address, the envelope being considered sufficient. This, of course, saves the labour of typing in the individual addresses, but it is rather discourteous, and destroys the effect which the imitation typewriting has laboured to produce.

It is better to type in the addresses afterwards and so complete the letter in a businesslike way. The ink used by the duplicating machine is, however, often of a different shade from that used by the typist in typing in the address. The difference is, if noticeable, sufficient to show the recipient that the communication is a circular. It is better, therefore, to fill in the address in a colour *altogether* different from that used for the text. Thus, if the text is in black, the address can be red, and so on.

With a duplicating machine, and an addressing-machine for the envelopes, there is little limit to the number of sales letters that can be got out. In an afternoon, the writer's own staff have often sent out as many as 10,000.

But now, leaving the mechanics of sales letters, one may turn to a consideration of the work they do. They can, roughly, be split up into two categories, the form-letters and the follow-up letters. Form-letters are original sales letters, sent out to secure or solicit orders, without reference to previous letters or business. Follow-up letters, on the contrary, follow up either previous letters or previous communications in an attempt to stimulate interest, secure orders, or obtain a decision.

Form letters are usually sent to potential purchasers, actual consumers, retailers, and retailers' or merchants' salesmen. Matters with which they can deal are as below:—

(1) Straightforward arguments in favour of the castings, showing why and how their purchase can be justified. If possible, letters of this sort should hinge on some known requirement of the potential purchaser.

(2) An account of new uses for which the castings can be employed.

(3) Details of a test or a testimonial made or given by some user of known importance, and unquestioned good faith.

(4) A request for information as to whether the castings already bought proved satisfactory.

(5) An offer of the castings on special conditions for a strictly limited space of time.

(6) An indication that the customer will shortly receive a visit from the founder's representative, with a hint that he has matters of strictly technical interest to discuss.

(7) The enclosure of invitations to attend exhibitions at which the castings are to be seen.

(8) Notification of changes in the selling methods, in agency, in representation, in address, in branch office management, and so forth.

(9) Offer of expert advice and assistance, literature, etc., in the selection or designing of castings for various purposes.

(10) Despatch of new or new edition of catalogue, booklet, etc.

When sales letters are sent out for retailers, or their salesmen, their purpose is usually to set up new centres of distribution, to pave the way for salesmen, to give help in the effective display, advertising, or counter-selling, of the castings, etc.

No less important than the subject-matter of the sales letter are, however, its construction and style. Generally, sales letters are too long. They begin with a trite generalisation, when it is of the utmost importance that they should open with something that will immediately grip and retain the reader's attention. This does not mean that they must be loud, bald, brusque, silly or sensational, but simply that the opening sentence must contain some arresting quality that makes the reader desire to learn more. Some days ago, a letter came to the writer from an important manufacturing firm. It began: "In these times of bitter competition, it is essential that all those who are called upon to make purchases should take into account the necessity of purchasing only those goods that give maximum economy in use." In that sentence is neither falsehood, figure, nor fact. It is diffuse, elaborate, wordy, boring. The writer did not bother to read what followed, simply because the first sentence gave the keynote of the letter and indicated its probable dullness. On the same day, he received a second letter, which began: "Have you considered the advisability of insuring your house-windows against breakage?" This letter aroused immediate interest. Insurance against window breakage had never crossed his mind. The letter went on to say why insurance was an advantage, what it cost, and so forth. Every sentence was read, because every sentence had a direct bearing on the letter's subject. All weak general remarks had been cut out. *Facts* were in each line.

Sales letters should, in their composition, follow the principles laid down for advertisements. They should attract attention, arouse and sustain interest, create desire, and induce action. But in their approach to the subject they can be a little more intimate than the advertisement can. They are personally-addressed messages, which means that they can talk more directly and individually. But that does not give them licence to be flippant or unduly familiar. There is no set rule as to their length, except that they should be only as long as the minimum length required to convey the message, which may mean a hundred words or five hundred. But out of every letter should be taken the hampering superfluities. Crispness and directness make a letter clamour to be read. But beware of a condensation so harsh that it makes the letter jerky or abrupt. Smoothness is essential, and clarity of thought no less so.

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Isolated sales letters, whether form-letters or follow-ups, are weak. If it is decided to circularise on these lines, a series of letters should be drawn up, each to be accompanied by an enclosure. Six is a good number, enough to drive home one's name and message; not enough to pester and irritate. Each letter should concentrate on one special selling argument, so that none of the series merely repeats what its predecessors have said. The last letter should sum up the whole series. They should follow each other at regular intervals, except that the first half of the total number should follow each other a little more quickly than the second.

The day of posting is important. The law of averages has shown that letters received on Wednesdays draw consistently better results than those received on Mondays or Saturdays. No man is in the right mood for attending to sales letters on Monday mornings. On Saturdays he is clearing up for the week-end, and pushed for time.

Sales letters should be sent sealed and stamped like ordinary letters. They secure more attention thus.

But when sending out a series of letters, it is obvious that sometimes it will not be necessary to post the complete set to each individual on the mailing list, either because business results at once, or because business is seen to be impossible. Some system of handling these cases, to prevent needless letters being sent, is essential. The next article of this series will describe such a system.

Novel Academic Methods of Preventing Oxidation in Iron.

By "VALLISHE."

There are now many methods in use to prevent oxidation of iron. One of these methods consists in the addition to pig-iron, when in a state of fusion, of from 2 to 10 per cent. of copper, tin, nickel, or antimony, by which addition, the iron is rendered more malleable and less subject to oxidation. A second method consists in imparting to the iron a coating of steel, or rather a species of iron, containing less carbon, and of course approaching to steel. This is effected by the addition of one part of blister steel to four parts of molten cast iron, and then adding scrap iron to the mass, until an iron rod is no longer rendered brittle by being dipped in the mixture. With this compound, common iron is coated in the same manner as pursued in the case of covering iron with brass; but various methods are adopted, according to the size and nature of the article to be coated. Where it is at the end of a bar of iron, such as an axle, and is to be of a particular form, this form may be given to the crucible, thereby making it a mould, and when in a state of perfect fusion, the iron, either previously heated or cold, is to be immersed in the melted mass, and when it is perceived that the mass is perfectly fluid, then the fire may be withdrawn, or the crucible be allowed to cool by any available means.

When the iron to be coated is immersed cold, the melted mass is immediately congealed, but it must be permitted to remain in the crucible till it again becomes fluid, and then it should be allowed to cool. If the whole is allowed to cool slowly, it is then soft, and may be turned in the lathe, and afterwards hardened by heating it and cooling it suddenly in the usual manner: but in this case care must be taken, as the coating and the iron have different powers of contracting. If the coated parts were suddenly immersed in water, it would certainly crack: the uncoated part must therefore be immersed up to the coated part, when the conducting power of the iron will cool the coating sufficiently quick to ensure a proper hardness.

A third method of preventing oxidation, is by case hardening the metal, by the use of the ferrocyanide of sodium, calcium, or barium.

In order to apply the ferrocyanide, an alkaline bath, formed with carbonate of soda, or other alkali, is used. This bath may be a crucible or large basin built in the brickwork of the furnace, which should be a reverberatory furnace and previous to being used, should be raised to a white heat; the iron to be case-hardened requires to be previously heated to nearly a red-heat, and then immersed in the bath, and there raised to a heat sufficiently high, after which it must be immediately immersed in the ferro-cyanide previously fused in another vessel; but if the quantity of iron to be case-hardened is small, it would not be advisable to fuse the ferro-cyanide (as it is very soon decomposed), but immediately on taking it out of the bath it must be sprinkled with ferro-cyanide; should ferro-cyanide of potassium be used, it is found that the alkaline bath prevents effectively the corroding of the iron.

A fourth scheme consists of a method of coating copper, or the alloys of copper or iron, with platinum. Platinum is dissolved in *aqua regia*, and the iridium which remains undissolved as a black powder, separated by filtration, then evaporated to dryness, and when cold a quantity of caustic potash, equal in weight to the metallic platinum employed is to be dissolved in water, and poured on the chloride of platinum. This will precipitate the platinum of an impure yellow colour; a quantity of solution of oxalic acid equal to the weight of the metallic platinum, is now to be added without pouring off the solution which remains on the precipitate; the solution is then to be boiled till the precipitate is entirely dissolved; a small quantity of iridium will still remain, which, together with any other impurities, must be separated by filtration; caustic potash equal to twice the weight of the metallic platinum is to be dissolved in water, and added to the above. The solution is now ready for platinising the copper or iron article which is to be coated with platinum. The article to be coated is to be put in a vessel of glass or earthenware, and the above solution is to be poured in, sufficient to cover it; let it then be connected with the positive pole of a Daniel's or Bunsen's battery of one or more pairs of plates, according to the size of the article to be coated, and a piece of platinum foil in connection with the negative pole is to be immersed in the solution. The deposition of the platinum in a metallic state on the surface of the metal article immediately commences, and may be continued till the required thickness is obtained.

Scientifically speaking, there is no objection to any of these methods, as regard the effectual result of their application, but looking at the matter commercially, the simple question naturally suggests itself—will it pay? Will not the cost of adding from "2 to 10 per cent. of copper" swallow up the supposed gain in point of freedom from oxidation?

"Safety" Clothing.

Moulders would be well advised to imitate the fashion prevalent amongst neo-Georgian "flappers" of wearing Russian boots, by adopting the habit of wearing, whenever in contact with liquid metal, the spats and gaiters which the stores will always provide. Only last week a foundry employee in London lost his toes, through not wearing safety clothing. We have a little sympathy with men in their negligence, as for years we wore blue glasses for furnace working, realising quite well the risks we were taking, but, unlike our friend, the moulder, we did make efforts to get a glass having the practical conditions which we insisted upon (density), together with an ability to arrest the actinic rays (dangerous). If the moulder has objections to spats on any ground whatsoever, he should voice them. Recently, a group of moulders stated their case to Mr. H. G. Sommerfield, of Charterhouse Chambers, Charterhouse Square, London, E.C.1, and as a result he has designed and placed upon the market a combination asbestos and thin leather spat. The object sought has been to associate stoutness with light weight. In place of buckles, a quick-release clasp has been incorporated, so that not only can they be fastened on in a minimum of time, but also—and what is more important—they can be rapidly discarded in case of accident.

A Cast-Iron Bar of 2 in. x 1 in. section and 3 ft. between supports will break with an approximate load of 27½ cwts. loaded in the centre.

Elimination of Impurities from the Basic Bath.*

By G. Reginald Bashforth.

The introduction of the basic process has enabled the employment of a wider range of raw material than previously possible. In a basic-lined furnace it is possible, by the maintenance of a very basic slag, to produce a high-grade steel from raw materials containing comparatively large amounts of sulphur and phosphorus.

The elimination of impurities may be conveniently divided into two stages; first, the melting-down period, and secondly, the refining period after the bath has completely melted.

As soon as ever the flame commences to play on the surface of the charge, the chemical changes begin. It is well known the iron has a great affinity for oxygen, and that this affinity increases at high temperatures. In the open-hearth furnace this demand for oxygen is either supplied by the free oxygen in the furnace, or, by the dissociation of carbon dioxide or water vapour in the furnace gases. The result of this oxidising action of the flame is the formation of scale on the surface of the charge. Eventually, this scale, which even at the temperature of the open hearth furnace is infusible, shells off and falls to the bottom of the hearth, where it combines with lime and silica to form a fusible slag.

In the acid process the slag so formed is essentially an iron silicate, whereas in the basic furnace, by additions of lime and limestone, the slag is basic. Besides the formation of scale, the action of the flame is also responsible for the oxidation of varying amounts of carbon, silicon, phosphorus and manganese.

Sulphur, however, is in most cases unaffected during this period, and occasionally even shows a slight increase, probably due to the absorption of this element from the furnace gases. Whether these oxidation processes are due to the direct action of the flame or to the scale formed thereby is a little doubtful. Most probably it is due to the impure metal, as it melts, running down on to the scale lying on the hearth, whereby the impurities are oxidised.

On oxidation the carbon passes away in the gaseous condition, while the other impurities pass into the slag, which must be highly basic to retain the phosphorus.

Sometimes, for instance, when working with a large percentage of pig-iron, it is advisable to enhance this oxidising of the flame by charging oxides simultaneously with the pig-iron and scrap. On the other hand, when working with a large percentage of scrap it may be necessary for successful working to counteract this action by charging carbon in the form of anthracite or coke.

The removal of carbon from the molten bath is readily achieved by the addition of iron ore, which, being of a density very nearly the mean of those of slag and steel, sinks into the metal till about half covered by it. The oxygen in the ore thus comes into intimate contact with the carbon in the bath, which is thereby rapidly oxidised. It is apparent that the larger the ore the better the oxidation is likely to be. Fine ore might remain entirely in the slag and act slowly and inefficiently in reducing the carbon content.

The evolution of the gases from the oxidation of carbon gives rise to a boiling effect which is of the greatest importance in the process. The advantages of this boil are threefold. Firstly, the bath is more intimately mixed throughout, thus enhancing the chemical reactions. Secondly, the exchange of heat between metal and flame proceeds more actively. Lastly, the action of the flame is made more proficient, since the ascending gas bubbles lift particles of the metal above the slag, thus bringing them into direct contact with the flame. These particles become oxidised and, sinking back into the bath, assist in the oxidation processes.

Order of Impurity Removal.

A very important point in working a basic furnace is the removal of phosphorus before carbon. If, as when working with a low silicon and a high phosphorus pig-iron, the carbon is removed before the phosphorus, it is sometimes difficult to bring the phosphorus down to limits. This is due to the absence of the stirring action caused by the boil, which brings about the essential intimate contact between metal and slag.

The oxidation of phosphorus probably takes place according to the formula:—

$$2P + 9FeO = Fe_4P_2O_9 + 5Fe.$$

The phosphate of iron so formed, however, is unable to withstand the action of the other reducing agents, and is therefore only stable in highly oxygeneous surroundings. The next step is the conversion of this phosphate of iron into a more stable phosphate, namely, phosphate of lime, which readily takes place providing the slag is rich in lime and sufficient oxidising.

$$Fe_4P_2O_9 + 4CaO = Ca_4P_2O_9 + 4FeO.$$

Under certain conditions even this phosphate of lime may be reduced, and the phosphorus caused to re-enter the metal. For example, by carrying too far the removal of iron oxide from the slag causes a more than normal effort on the part of the reducing agents to satisfy their affinity for oxygen, resulting in decomposition of the lime phosphate and the re-entry of phosphorus into the metal. The extent to which the manganese additions to the bath causes re-phosphorisation depends on the degree of oxidation of the slag at the time. The author is aware that several firms make large ferro-manganese additions to the bath, but the state of oxidation of the slag is such as to prevent re-phosphorisation.

The re-entry of phosphorus into the metal may also be caused by an increased silica content of the slag. This is often observed when part of the furnace structure collapses, and silica bricks are caused to be dissolved in the slag.

The reaction may probably take place according to the formula:—

$$Ca_4P_2O_9 + 4SiO_2 = 4CaSiO_3 + P_2O_5.$$

The phospheric acid liberated by the reaction is immediately reduced and phosphorus re-enters the metal.

Since it has been shown that a high Si content retards the removal of phosphorus, it is essential that the amount introduced into the furnace should be limited. In passing it may be interesting to note the sources from which the element is brought in, namely:—(1) From the metallic charge; (2) from the sand adhering to the pig-iron and silica content of limestone, lime and other feed materials; (3) the silica that reaches the bath from the furnace structure, that is, that which drips from the roof, blocks, walls, etc.; and (4) the silica absorbed from the hearth. The dolomite contains about 6 per cent. of silica, and since the dolomite consumption amounts to about 4 per cent. it will be seen that this factor is at least of importance. Since silicon is present in small amounts its removal presents no difficulties, and the reaction is represented by the formula:—

$$Si + 3FeO = FeSiO_3 + 2Fe.$$

The iron silicate so formed, being lighter than the metal, floats into the slag, where lime and magnesia being more powerful at high temperatures than the remainder of the bases, take up the silica themselves and set the iron free.

$$FeSiO_3 + CaO = CaSiO_3 + FeO.$$

This reaction, however, does take place completely but the silica exists as the mixed silicate.

The elimination of manganese likewise presents no trouble, it is gradually oxidised and passes into the slag. A large percentage of the manganese present in the original charge is, in fact, eliminated during the melting down period. The removal of manganese seems to depend on the following equations:—

(i) $2Mn + O_2 = 2MnO.$
(ii) $3MnO + Si = MnSiO_3 + 2Mn.$

* A Paper read before the Sheffield University Metallurgical Society.

Manganese, which possesses a lower oxide-tension than iron, is capable of removing oxygen from its combination with iron, and is thereby converted into strongly basic manganese oxide.

This manganese oxide tends to combine with any free acids present. In the absence of free acids the manganese is able to replace the iron in iron silicate:—

$$Mn + FeSiO_3 = MnSiO_3 + Fe.$$

This reaction appears reversible and, in light of Dr. Naske's work in Stahl und Eisen, 1907, it seems to depend on the ratio of iron oxide to manganese oxide in the slag.

(*a*) When:—FeO : MnO = 1. Equilibrium exists.

(*b*) If, MnO > FeO, manganese is reduced to the metal.

(*c*) If, MnO < FeO, manganese is oxidised from the metal.

There are, however, other conditions governing the reduction of manganese from the metal. Lime, as already shown in the case of iron, is able to decompose the manganese silicate, liberating manganese oxide, which is soluble in the slag, or in the mixed silicate of lime, iron and manganese.

$$MnSiO_3 + CaO = CaSiO_3 + MnO.$$

If the slag is deficient in oxide the manganese oxide so formed will be reduced by the reducing agents present, and metallic manganese will pass back into the metal.

A reduction of manganese from the slag is often observed after feeding lime and fluor-spar. This is probably due to the fact that the fluor-spar increases the solubility of lime in the slag, thereby causing, in accordance with the law of mass action, a more intense reaction between the lime and manganese silicate, resulting in the liberation of a greater amount of manganese oxide, which is reduced by the reducing agents present.

The removal of sulphur is a little more difficult and doubtful.

In the field of non-ferrous metallurgy great use is made of the so-called precipitation process for the recovery of metals from their sulphides. This process depends on the displacement of the metal from its sulphides by a less noble metal, that is, by a metal with a lower sulphide tension. The process generally takes the form of heating the sulphide with iron, whereby the metal is set free and the sulphur combines with the iron. This method is employed for obtaining mercury from cinnabar and antimony from stibnite. The same principle underlies the disulphurisation of iron by manganese. The addition of ferro manganese to the bath causes the decomposition of the iron sulphide, liberating the iron and forming manganese sulphide, which passes into the slag.

$$Mn + FeS = MnS + Fe$$

The process, however, is too costly to be adopted in commercial practice.

A very interesting method used at a large Canadian steel works is described in the journal of the Canadian Mining Institute, 1907. Their practice is to reduce the carbon content of the bath very low and then to bring it up again by the addition of pig-iron. The author of that paper remarks, "whether the sulphur is burnt out or whether it passes into the slag is not known, but considerable quantities have been removed in this way." He further adds, that the process is a tedious one and should be avoided whenever possible.

The method suggested by Saniter,* based on the use of calcium chloride in conjunction with a very limey slag, rendered fluid with fluor-spar, has been successfully adopted at many steel works.

It is obvious that the removal of sulphur depends on its conversion into some form which is soluble in the slag, but not in the metal. This form appears to be calcium sulphide, and therefore desulphurisation may possibly be represented by the formula

$$FeS + CaO = FeO + CaS$$

This reaction, however, is reversible and the establishment of an equilibrium will be governed by the Laws of Physical Chemistry. According to the Law of Mass Action, "the intensity of a chemical action is proportional to the concentrations of the reaction molecular species." (Dean and Schenck.) Therefore, by increasing the concentration of lime in the slag, the reaction should move towards the right, while an increased iron oxide concentration should cause the reverse action. This appears to take place in actual practice.

If the slag becomes very oxidising, the removal of sulphur is not only retarded, but in some cases it is even caused to re-enter the metal. This is sometimes observed after feeding large amounts of oxide.

The author has known occasions when considerable difficulty has been experienced in removing comparatively small amounts of sulphur owing to overfeeding with scale in the earlier part of refining.

When there is much sulphur to be eliminated, scale should be used very sparingly, if at all. Not only is it likely to contain a considerable percentage of sulphur, but also, owing to its density it all remains in the slag, thereby increasing the iron oxide concentration of the slag and consequently retarding the removal of sulphur.

On the other hand, when pigging back the carbon content, thereby tending to remove oxygen from the slag, the elimination of sulphur is enhanced. The increased desulphurisation observed on feeding ferro-silicon, ferro-manganese and other reducing agents, is probably, at least partly due to their deoxidising effect.

The essential conditions for the removal of sulphur therefore appears to be, the maintenance of a very limey slag (52 to 55 per cent. of lime), free from metallic oxides and rendered fluid with fluor-spar. These conditions would be expected after consideration of the nature of the above reaction.

* Iron and Steel Transactions 1891, vol. 2.

Patent Specifications.

The following list of patent specifications accepted have been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full specification can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

7,766. GILL, H. A. (Ruggles-Coles Engineering Company). Dust-collectors. (March 23, 1925.)

21,009. STONE & COMPANY, LIMITED, J., AND MIDGLEY, A. H. Casting of metals. (September 5, 1924.)

21,146. HANCOCK, L. J., AND HANCOCK & COMPANY (ENGINEERS), LIMITED. Blowpipe machines for cutting metal. (September 8, 1924.)

27,917. WADE, H. (INTERNATIONAL NICKEL COMPANY). Manufacture of alloys. (November 21, 1924.)

3,416. GRUMPELT, O. F. A. E. Apparatus for cutting metals. (February 6, 1925.)

5,647. HUTCHISON, R. Plant for use in the process of manufacture of metal tubes. (March 2, 1925.)

13,872. CONTI, E. Solder for aluminium and its alloys. (July 21, 1924.)

13,906. INTERNATIONAL PROCESSES, LIMITED, AND RYNER, A. Furnaces. (May 27, 1925.)

14,883. JUNKER, O. Process for the deoxidation and for the protection from oxidation of metals. (June 8, 1925.)

Contracts Open.

Beckenham, January 14.—Water plant, etc., for the Beckenham U.D.C. Mr. J. E. Tapper, engineer and manager. (Fee £1, returnable.)

Cape Town, January 14.—Steelwork, etc., for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 2,643.)

Coalville, Leics., January 5.—Mains and fittings, for the Coalville U.D.C. Mr. L. L. Baldwin, A.M.I.C.E., water engineer, Council Chamber, Coalville.

Dundee, January 14.—Drainage pumps, for the Corporation. Mr. D. H. Bishop, general manager and engineer, Electricity Supply Department, Dudhope Crescent Road, Dundee. (Fee £1 1s., returnable.)

Durban, January 8.—Pig-lead, for the Durban Corporation. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 2,644.)

Hastings, January 4.—Mains, for the Corporation. J. Taylor & Sons, Caxton House, Westminster, London, S.W.1. (Fee £5 (cheque only), returnable.)

Milton Regis, Kent, January 23.—Steel main, for the U.D.C. Mr. H. Filmer, clerk, Town Hall, Milton Regis.

Wallasey, Cheshire, January 12.—Pipes, for the Corporation. Mr. G. Livsey, town clerk, Town Hall, Wallasey.

Catalogues Received.

Dust Removal.—Messrs. James Keith & Blackman Company, Limited, of 27, Farringdon Avenue, London, E.C.2, are circularising the foundry trades with reference to the provisions of the Cleaning of Castings Regulations, pointing out that they are prepared to take over the works' problems, and satisfy the Home Office Inspectors in this respect.

Modern Case-Hardening Practice.—The research staff of Messrs. David Brown & Sons, Limited, of Park Works, Lockwood, Huddersfield, in collaboration with their publicity, have achieved a distinct success in the production of a thirty-two-page art catalogue. The object sought has been to trace the process from the selection of the steels, both plain carbon and alloy, to the testing of the finished product, duly stressing the importance of the carbonising material. During their studies on the carbonisers, the laboratory has developed one, known as D.B.S., which is claimed to be free from adulteration, and that every constituent has a definite rôle to play. The pamphlet is illustrated by fifteen illustrations, including eleven micro-photographs, two sulphur prints, and two diagrams.

Iron and Steel Works and Foundries, Raw Materials and Finished Products.—Two pleasing catalogues covering the same ground but of different sizes have been received from the Consett Iron Company, Limited, of Consett, co. Durham. They are beautifully bound in soft leather, and the art pages are edged with gold. Two-colour printing has been effectively incorporated. The object has been to cover the whole of the products marketed by the Company, starting with coal, and through coke and its by-products, pig-iron, ingots, slabs and blooms, steel plates, steel sheets, sections, joists and rails, castings, silica and fire bricks, slag, lime and lime stone. The technical side has been splendidly covered by the inclusion of a number of useful tables. At the end some five pages are included for notes. All together there are 140 well-illustrated pages in the large edition and 120 in the smaller one.

Foundry Specialities. — Whilst foundrymen usually associate the names of James Keith & Blackman Company, Limited, of 27, Farringdon Avenue, London, E.C., with cupola fans, this does not by any means embrace the whole of their manufactures. We have just received advance copies of four catalogues of uniform style illustrating and describing (1) centrifugal fans; (2) light indoor fittings; (3) soldering irons and stoves; and (4) small gas-heated furnaces and brazing blow-pipes. The first one covers an exceptionally complete range of fans in its 24 pages, and is accompanied by a fair amount of technical data. For the foundry owner the range includes fans suitable for furnace blowing, ventilation, and dust removal. Though reasonably complete, this pamphlet is augmented by the issue of other catalogues which are exclusively devoted to fans for one particular duty.

Catalogue GI—light indoor fittings—is devoted to what we should call indoor gas fixtures. In it are illustrated some very interesting designs. They are essentially fittings which have been designed by engineers for works' use. The important questions of vibration, cleaning, adjustability and light diffusion have obviously had the attention of people familiar with works conditions.

G149 is a four-page leaflet which describes an internally gas-heated soldering iron of novel construction and a high pressure gas-heated twin soldering stove. A stove rather similar in appearance is dealt with in Catalogue G153, but internally it differs and is rendered useful for tool room purposes. This pamphlet also illustrates a K.-B. blowpipe for use with high-pressure gas.

British Industries Fair, 1926. — In a communiqué issued by the Birmingham Chamber of Commerce, which, under the auspices of the Board of Trade, organises the Birmingham Section of the British Industries Fair, the attention of Trade Associations is specially directed to the fact that retail selling will not be permitted, under any circumstances whatsoever, at the Birmingham Section of the British Industries Fair.

Institute of British Foundrymen.

NEWCASTLE BRANCH.—Junior Section.

The Newcastle Junior Section had a very successful smoking concert on December 18, when the members had as their principal guests their patron, Mr. H. J. Young, F.I.C., and Mr. M. B. Herbst, the President of the Senior Branch.

The concert, which was held in the Grey Street Picture House Café, Newcastle-on-Tyne, attracted a larger number of members and visitors than has any previous function of the Junior Section.

The musical entertainment was followed by supper, after which a farewell speech was given by Mr. Young, who is leaving the district shortly after the New Year. In the course of this speech Mr. Young pointed out how very great things could arise out of very little ones in the fact that the first Junior Section in this country, namely, the Newcastle one, was conceived in his own office, and it seemed probable that it would become a great movement for good for the foundrymen in this country. He thought that much remained to be done for the boys in the foundry, and that the senior foundrymen and engineers did not always do what they might for them, whether in respect to encouragement, supervision, or help.

He pointed out, also, that many foundries in the district, represented on the Senior Branch, contributed neither boys nor money to the Junior Section, and he thought it time that this position was altered, and that the seniors should realise that they had a very grave responsibility. He had heard remarks about the lack of response or thanks from juniors for any help given to them, but, personally, he had never regretted giving assistance to any young boy, and even if there was no response or thanks, it was work well worth doing, and, in many cases, brought great rewards.

In conclusion he said that, although he would be joining another Branch of the Institute, he would always do his best for the Newcastle Junior Section, and hoped they would retain him as their patron. The speech was followed by the singing of "For he's a jolly good fellow" by all present. The whole of the arrangements for the smoking concert were carried out by Mr. C. R. Van der Ben (Hon. Secretary).

Personal.

MR. L. V. KENWARD, Mr. W. H. Paull and Mr. D. G. Snodgrass have been elected directors of the newly-constituted Birmingham local board of the Dunlop Rubber Company, Limited, of which Sir Eric Geddes and Sir George Beharrell are chairman and vice-chairman respectively.

Wills.

POZZI, C., of Princes Terrace, Bangor, Carnarvon, metal merchant £49,180

BROWN, T. J., of Kingsborough Gardens, Glasgow, metal and machinery agent ... £8,936

BIGGIN, H. A. S., of Hillside, Bore, near Sheffield, a director of George Tucker & Company, Limited, metal merchants £6,221

BLACKETT, W., of Claremont Place, Newcastle-on-Tyne, for many years an engineer in the service of R. & W. Hawthorn, Leslie & Company, Limited £17,333

BONSER, T. N., of The Chestnuts, Longcroft Avenue, Harpenden, formerly proprietor of Clark's Machine Tool Company, Luton £4,000

RIALL-SANKEY, CAPTAIN M. H., director and consulting engineer, of Marconi's Wireless Telegraph Company, Limited, a director of English Oilfields, Limited, a past president of the Institution of Mechanical Engineers, and vice-president of the Institution of Civil Engineers £12,538

Carbon-Monoxide Recorder.—A carbon-monoxide recorder developed at the Pittsburgh Experiment Station of the U.S. Bureau of Mines has been installed at the Liberty Tunnels in Pittsburgh. It is said to be so sensitive that it detects as little as 1 or 2 parts of carbon-monoxide in 1,000,000 parts of air.

XUM

Book Reviews.

Galvanising. By Heinz Bablik. Translated by Chas. T. C. Salter. Published by E. & F. N. Spon, Limited, 57, Haymarket, London, S.W.1. Price 12s. 6d. net. By post, 13s.

Though there may be other books written on this subject, we have constantly found difficulty in getting just that information we wanted in a reasonably quick time. For instance, for information on the Schoop process, we should naturally turn to a recent Paper read before the Institute of Metals, whilst standard text books would be consulted for other rust-preventing processes, and it is generally found that just small paragraphs are devoted to a selected number of methods. In Dr. Bablik's book the subject is dealt with completely from the technical point of view, so far as the present state of the art permits. The opening chapter outlines the author's views on corrosion, which are by no means universally accepted, but we insist that, as they check up with practice, they are not lightly to be discarded.

In chapter II, we have a small grumble, because Fig. 1, a graph, is illegible in places. It is, however, an exception, for the rest of the illustrations are splendid. This section is devoted to the structure of galvanised coatings. Sections through coatings resulting from electro-galvanising, Sherardising, hot galvanising, and "Schoop-ing" are detailed, and their respective merits discussed.

Chapter III is devoted to pickling, and, whilst thoroughly workmanlike in character, recent British work on the subject is not acknowledged.

Fluxes are next dealt with, and a number of original tables are given which should be helpful to the industry.

Chapter V, whilst the longest, is easily the best section of the book. Much of it relates to the author's original research, but he has not neglected to give due prominence to the work carried out in other countries. Full descriptions of the various machines, tanks, and processes are included.

A short but illuminating chapter is devoted to raw materials and waste products of hot galvanising. The German brand marks, together with the notes appended, will, no doubt, be of use as a reference.

Another short chapter deals with the theoretical principles of electro-galvanising, which presents a not too abstruse *résumé* of the subject, and includes an extensive table of customary electrolytes, their authors, and origin.

Chapter VIII is another practical section, and describes and illustrates the plant used for electro-galvanising. The next chapter treats of Sherardising, and includes a series of illustrations of the process being practised in a Continental works.

The Schoop process also receives a section to itself, which it deserves, as we envisage a considerable future for it, as no limits are set upon the size of the job to be coated.

The final chapter is devoted to testing and judging galvanised coatings.

The book is well indexed, but we deplore the non-existence of a bibliography. A text book, rather than individual Papers, read before scientific societies, is the proper place for such matter. The author is to be congratulated on his choice of translator, Mr. Chas. T. C. Salter, who has done him full justice.

The Life of Judge Gary: The Story of Steel. By Ida M. Tarbell. Published by D. Appleton & Company, 25, Bedford Street, Covent Garden, London. Price 12s. 6d. net.

The sub-title of this book is totally unwarranted, and could with equal truth be substituted by "The History of the United States of America" or "Chinese Metaphysics." No book bearing this sub-title can uphold such a statement without including the work of Huntsman, Bessemer, Siemens, Thomas, Martin, Heroult, and a host of others. It is not the "Story of Steel," but the story of the United States Steel Corporation. Judge Gary, according to the authoress, has been particularly careful never to allow the Corporation to manufacture more than 50 per cent. of the American production of any one particular item made in steelworks. According to our interpretation of the Judge's character, he thought "big," but seldom, if ever, talked "big," and if this is a true interpretation, we are surprised that his natural modesty did not prevail upon the authoress and her publishers to delete it.

The book is an American publication, and in places is awkward reading for Britishers, owing to the inclusion of Americanisms. For instance, on page 172 we have been totally unable to fathom the meaning of the following poorly punctuated sentence:—"Men frequently carry them [share scrip] with them and when a superior officer takes a chance to pull out a bill case from their hip pockets, and show the amount of their possessions." On the next page there is a sentence of over sixty words without any punctuation.

Johnson, the great lexicographer, had two biographers, Boswell and Macaulay. The former was a close personal friend of his subject, whilst the latter, a detached observer. To our mind Macaulay presents the truer picture of Johnson, as Boswell was perhaps dominated too strongly by his friend's character. We feel this biography has similarly suffered. The authoress has certainly had access to a large amount of personal documents, but her findings apparently require quotations from prominent associates for confirmation. For instance, Mr. Schwab's speech made at a complimentary dinner to the Judge is twice quoted, but because of this extra emphasis we have received the impression that Mr. Schwab and Judge Gary always have been, and probably always will be, formal business friends.

The wonderful success achieved by the Judge is due to his smartness in either advising the United States Government beforehand of intended moves by the Corporation, or insisting that if his company was doing anything contrary to the public good he would make it his business to have it changed. The Corporation he envisaged as a vertical as opposed to a horizontal trust; that is, one being complete—from iron ore, through transportation, to finished wire, rod or nail, rather than pure monopolies.

The book deals rather exhaustively with the Judge's ancestry and early days, and gives an impression that the love affairs and domestic life would be dealt with, but beyond bald statements, once the boy has been breeched, it is purely his business character that is dealt with. The "Safety First" movement received Judge Gary's attention very shortly after having assumed the chairmanship of the Corporation. From what we gather of character of the labour employed—Poles, Czechs, Italians, Russians, with, of course, the English-speaking races—one can well imagine that accidents would be a formidable factor. It is obviously difficult adequately to instruct a man in his duties by signs. The Judge, realising this, gave his whole-hearted support to "Safety Committees." This phase, together with "Welfare Movements," and the offering of shares on favourable terms to the workers, he believes sufficient to eliminate the need of dealing with outside trade union leaders. The unions must, in his views, be represented by men within the establishment.

The book under review is not one which is to be added to a technical library, but rather to the home bookcase. The authoress is obviously quite unfamiliar with the manufacture of iron and steel, as she claims for the Tennessee Coal, Iron and Railroad Company that "it is the only place in the world . . . . where a blast furnace has raw materials in its backyard." The Middlesbrough district has Cleveland ore and Durham coke at hand with which to work. We would, however, advise our readers to obtain this book, as it will add materially to the knowledge of the American metallurgical industries and the mental make-up of America's captains of industry.

New Companies.

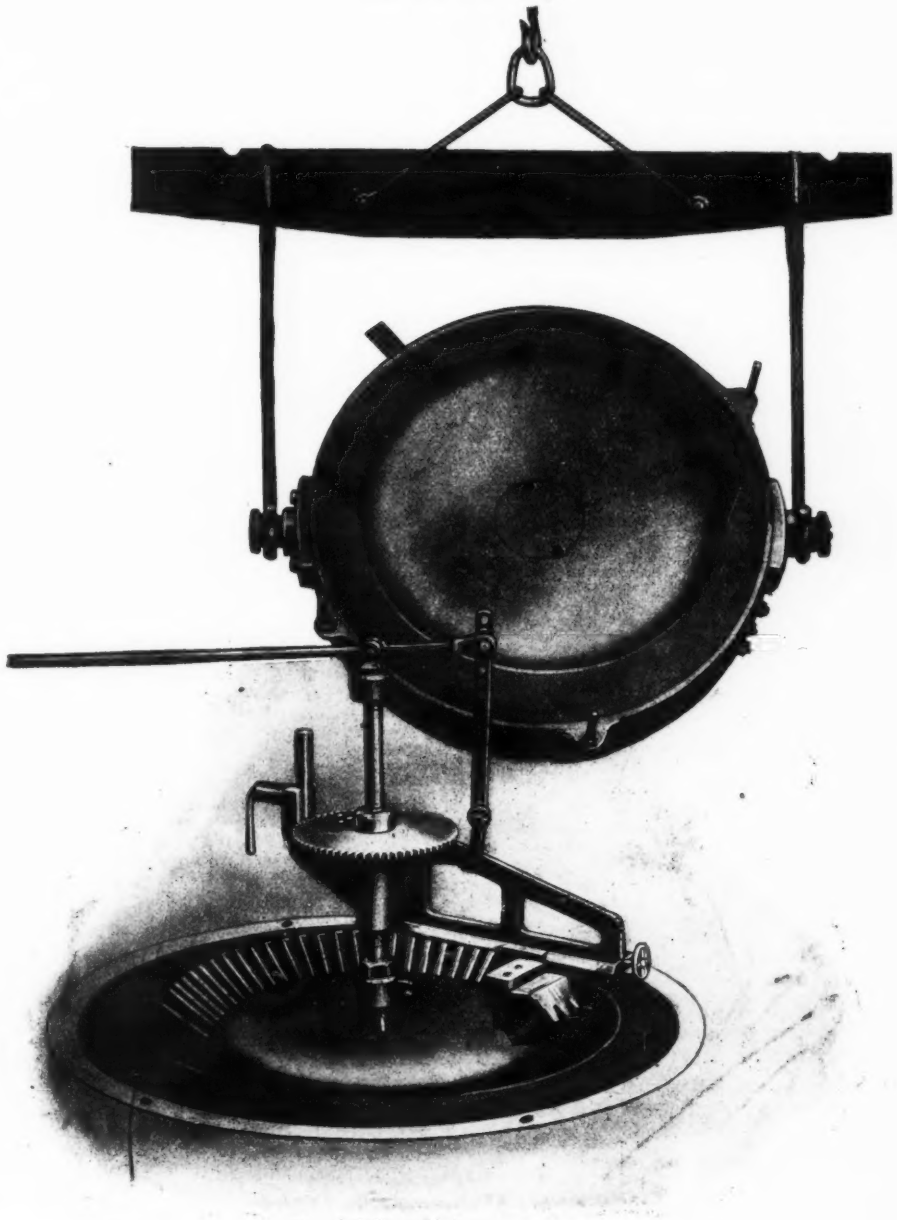
British Maximum, Limited, Vulcan Works, Patricroft, Eccles.—Capital £30,000 in £1 shares. Smelters.

G. B. O., Limited.—Capital £5,000 in £1 shares. Ironfounders, mechanical engineers, etc. Directors: W. Grimshaw, E. Barlow and J. Ogden, 453, Blackmoorfoot Road, Huddersfield.

Rowarth Atkins Steel Works, Limited, Bessemer Road, Attercliffe, Sheffield.—Capital £5,000 in £1 shares. Directors: G. H. Eaton, A. R. Atkins and F. Oldak.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS, (MANCHESTER), LIMITED,

BLACKFRIARS, MANCHESTER.

Company Meetings.

Cleveland Bridge & Engineering Company, Limited.—The thirty-third annual meeting was held at Bank Top, Darlington, on Dec. 21. In moving the adoption of the report, the chairman, MR. W. E. PEASE, M.P., said that there had been practically no alteration in trading conditions since last year, although there had been a considerable reduction in the price of steel, which was now only a small percentage over pre-war price. In spite of this the Continent were still underselling the steelmakers, and had sent 2½ million tons of steel into the country last year, which would this year be increased to three million tons. This weight would give continuous employment for a further 135,000 men if made in this country. Taxation continued to be a heavy charge, and the amount paid by the company in national insurance, income-tax, rates, etc., for the last twelve months was equivalent to about 9 per cent. on the ordinary capital. He was afraid he could hold out no hope that there would be any relief from this burden for a series of years. During the year a large proportion of the contracts the company started the year with had been completed or were nearing completion, and although a few new contracts had been obtained, they were not sufficient to ensure a full year's working without further bookings. A large contract in Calcutta was not proceeding as fast as it should, owing to the fact that the Corporation had let the trenching to native contractors, and the company had been repeatedly held up owing to their slow progress.

Vickers, Limited.—A meeting of the shareholders was held in Sheffield, on December 17, for the purpose of considering resolutions providing for the reduction of the capital, and for certain alterations of the articles of association. MR. DOUGLAS VICKERS, the chairman of the company, presided. The chairman said the directors approved of the recommendations for the reconstruction of the company made by Mr. Dudley Docker, Mr. Reginald McKenna, and Sir William Plender, their advisers, and stated that no scheme of reconstruction had ever been put forward on greater authority. Having explained the necessity of bringing the resolutions before the shareholders at such short notice, the chairman reviewed the circumstances which led to the calling in of their advisers. In 1913 the company had reached the summit of its prosperity. The following year the war had come. They had been among the first firms to be controlled. They had been obliged to make extensions to their armament plant at once, and at the end of the war they had still been extending. With the end of control after the war they found themselves with the war plant in Sheffield and Barrow increased by more than half, and in the Erith group of works more than doubled; with the Wolseley works much increased, and with a very large factory for fuses and cases on their hands in Birmingham. They had applied themselves to finding civil work for these factories, or rather for such parts of them as could be used. They had tried a good many new manufactures, most of which had been successful. Some other new ventures had cost money in starting, but now promised to do better. Some were failures—notably the attempt to make sewing machines on the machine-gun plant at Crayford. Before the war Vickers had an electrical department which it had been the board's intention to extend. However, the opportunity had offered itself to secure control of the British Westinghouse Company in association with the Metropolitan Carriage Wagon and Finance Company. These relations had led to a fusion with the latter company in 1919. It was then hoped that the earnings would help to bridge over the period during which it was obvious that armament orders would be only small. The Weybridge Works were doing well. The Erith Works were making reasonable profits out of war material and civil products, and Crayford and Dartford were about paying their way. The electrical interests were doing reasonably well, but though steady, the dividends were not as large as anticipated. On the other hand, the Wolseley Company had been causing anxiety. The smaller outside interests, most of them arising from the investments they had made in other companies to supplement their manufactures during the war, had mostly given a great deal of trouble. In respect of the elimination of waste in works' management and production, a great deal had already been done. One of the advantages of the present scheme was that the board were now in a position to shut down plant and wind up subsidiary and affiliated enterprises, which did not, or were not likely to, contribute to the earnings of the company. The chairman confirmed the last paragraph of the report, namely, that the company held over £2,000,000 of Government securities, apart from the further large liquid resources held through subsidiary companies and not disclosed. In concluding, he repeated that the alterations proposed had the support of the board, which included the three largest shareholders in the company. He formally moved the resolutions, which were seconded and carried.

Trade Talk.

BROMFORD, LIMITED, Rocky Lane, Aston, Birmingham, have changed their name to the Bromford Tube Company, Limited.

E. A. HERBERT & COMPANY have removed their Birmingham Branch from 25, Suffolk Street, to 35s, Summer Hill Street.

HADFIELDS, LIMITED, of Sheffield, have officially denied the report that they intend to establish steelworks at Dunedin, N.Z.

MR. E. M. BROWN, proprietor of the business of Ernest M. Brown & Company, East Parade, Huddersfield, general pattern makers, etc., has retired from business and has sold the undertaking, which he has carried on for many years past as sole proprietor, to Mr. S. Armitage. Mr. Armitage has been actively associated with the firm for the past fifty years, and for many years has been works manager.

CONSIDERABLE EXTENSIONS are being made at the Swansea Vale Spelter Works, Llansamlet, in the roasting and acid departments. The work is part of a programme which is under consideration with a view to the equipment of the whole of the plant to meet the keen present-day competition. The production of the roasting and acid departments will be increased, and the whole of the processes in these departments are being modernised.

THE ADJOURNED conference between the Minister of Labour and representatives of the engineering employers and the unions on the question of working hours took place in London on Dec. 21. The Minister made it clear to the employers and the unions that he was doing his best to place British industry on a fair basis in competing with foreign countries. He stated that he had been in communication with Continental Governments on the question of the clause in the Treaty of Versailles, and had received replies from Germany and Belgium that those Governments were prepared to take part in a conference with a view to establishing a uniform 48-hour week, and what was more important, a uniform interpretation by all organisations of the 48-hour week agreement. No definite replies had been received from France and Italy, but further steps were being taken.

NEGOTIATIONS FOR THE amalgamation of the Mountstuart Dry Docks & Shearmans, Limited, with Elliot & Jeffery, Limited, Cardiff, have reached the final stage, subject to the confirmation of shareholders of the former company. Elliot & Jeffery have acquired from Mr. Frank Shearman the major portion of his interest in the Mountstuart Company, and the directors have agreed to a fusion of the companies, and also entered into an agreement with John & Thomas Elliot for the running of the combined businesses. Mr. Frank Shearman retains an interest and a seat on the board. The other directors will be Mr. John Elliot, Mr. Thomas Elliot, Mr. J. E. Emlyn Jones, Mr. T. H. Morley, Mr. R. Williamson, and Mr. F. E. Lewis. Mountstuart Dry Docks & Shearmans, Limited, are a very old-established company, with a share capital of £725,000, of which £525,000 is in deferred shares. Elliot & Jeffery, Limited, are also an old-established private company, with a capital of £60,000.

Company Reports.

Howard & Bullough, Limited.—Quarterly dividend, 6d. per share.

Nantyglo & Blaina Ironworks Company, Limited.—Receipts from royalties, rent, etc., £29,274; two instalment dividends on account of arrears on 8 per cent. preference shares, making £5 per share, paid.

Electrolytic Zinc Company of Australia, Limited.—Depreciation, £140,000; gross profit, £510,073; net profit, £375,380; brought forward, £98,920; available, £474,300; debenture sinking fund reserve, £12,100; written off investigational research and general development account, £20,000; equalisation reserve, £40,000; new plant for West Coast mines, £20,000; dividends Nos. 6 and 7, £216,268; carried forward, £165,932.

MR. R. JENKINSON, of Swinton, near Rotherham, has been appointed metallurgist to Holman Bros., Limited, of Camborne, Cornwall.

ALLOTMENT LETTERS for rights and excess shares in connection with the issue to shareholders by Johnson & Phillips, Limited, of 100,000 ordinary shares of £1 each at 40s. per share have been posted.

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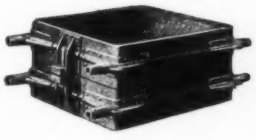
It's the Rolled Steel Construction that makes Sterlings different. Each box has built into it many years of hard service.

For both jobbing and repetition work



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BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—In the holiday conditions prevailing at this season, it must necessarily follow that market operations in iron are naturally on a restricted scale, and in Tees-side during the current week business has been virtually suspended. The close of the year, at any rate, finds the Cleveland iron trade in a somewhat more hopeful position as regards demand for consumption, and, with prices tending to much higher levels, the recent advance in quotations for No. 3 G.M.B. being a distinct pointer in that direction, it may be anticipated that buyers will early avail themselves of the opportunity of purchasing more extensively for future requirements than has been the general rule during the past year. Consequently home sales are likely to expand as soon as buying is resumed, and ironmasters in Cleveland are now able to regard with some degree of equanimity the decline in the export trade. In consequence of increased costs, current quotations are now as follow:—No. 1 Cleveland, 71s. per ton; No. 3 Cleveland G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; No. 4 forge, 66s. 6d.; mottled and white, 66s. per ton.

The demand for hematite has experienced some slackening during the past fortnight, but the shortage of supplies is just as pronounced as ever, and it will take weeks before the arrears can be fully overtaken. Probably more furnaces would be lighted up, as there is every evidence of a sustained demand, but there seems no chance of obtaining the essential supplies of coke. Makers, however, have refrained from exploiting the situation by advancing prices, but quotations are very firm at 76s. 6d. per ton for East Coast mixed numbers and 77s. for No. 1 hematite. On the North-West Coast prices are also firm, with Bessemer mixed numbers £4 1s. 6d. c.i.f. Welsh ports, £4 5s. per ton delivered at Glasgow, £4 8s. 6d. per ton delivered at Sheffield, and £4 12s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—The position of the foundry pig market in this area is practically unchanged for the time being, but, with hopes of a general revival of trade early in the New Year, the outlook bears encouraging signs of improvement. In the meantime the nominal quotations for delivery in Manchester remain at 73s. 6d. to 74s. for Derbyshire No. 3 and 72s. 6d. to 73s. for Lincolnshire. These are the only two makes which are of particular interest to Lancashire consumers, as Northamptonshire iron would cost 75s. 8d. delivered here, and Cleveland iron 79s. 2d.

THE MIDLANDS.—As recently experienced in these markets, prices for foundry iron are quite strong, and there is at present no sign of concessions being made, although, owing to the holidays and the fact that many of the founders will be stock-taking at the end of this month, the demand has eased off to some extent.

Scrap.

Transactions in this class of foundry material have recently been in negligible volume, with buyers scarce in view of immediate stocktaking operations. In Lancashire ordinary cast scrap is plentiful, dealers still quoting 70s. per ton delivered, while some ask 72s. 6d. for good lots of broken machinery metal. Textile scrap is still rather scarce, and as it is expected that the textile engineers will have need of this quality in the early spring, it might be worth while to hold back a little; certainly up to 75s. per ton should be asked for good broken loom scrap. In Scotland machinery cast-iron scrap is being disposed of fairly freely at 73s. to 74s. 6d. per ton, and ordinary cast-iron scrap to the same specification at about 67s. 6d. per ton. Steelworks cast iron in furnace sizes is still around 65s. to 66s. per ton, and old cast-iron railway chairs 72s. 6d. to 73s. 6d. per ton, but the latter are not too plentiful. Light cast iron and firebars have improved a little from 56s. to 57s. 6d. per ton, but re-rolling rails still show no change around 65s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

A rather extraordinary development was marked in the closing hours of the standard copper market, just prior to the adjournment for the holiday recess, when values took a sudden upward turn, and rapidly rose to about the £60 5s. level, a figure not approached for some weeks past. The advance may probably be due to a natural reaction after weeks of comparative depression, as nothing has occurred that would produce any violent change of opinion as to the immediate prospects of the metal. Current quotations:—*Cash*: Wednesday, £59 12s. 6d.; Thursday, £59 17s. 6d.; Monday, £59 15s.; Tuesday, £59 5s.; Wednesday, £59 7s. 6d.

Three Months: Wednesday, £60 12s. 6d.; Thursday, £61; Monday, £60 17s. 6d.; Tuesday, £60 7s. 6d.; Wednesday, £60 7s. 6d.

Tin.—A similar movement to that above outlined occurred also in tin last week, but in this instance it is not so surprising, as the metal has been fluctuating heavily for some weeks. Up to the present there has been, as usual at this season, a tendency to restrict commitments, and it is possible that the great boom in rubber shares has in some degree diverted attention from speculation in tin. The outlook, nevertheless, is considered very healthy, general consumption being maintained on a comparatively large scale, and home stocks being, in fact, dangerously low. Current quotations:—*Cash*: Wednesday, £286 5s.; Thursday, £288; Monday, £289; Tuesday, £287; Wednesday, £287 15s.

Three Months: Wednesday, £279 5s.; Thursday, £280 15s.; Monday, £281 5s.; Tuesday, £280; Wednesday, £280 12s. 6d.

Spelter.—Recent quotations for this metal, showing a fairly substantial decline in values, are somewhat difficult to understand, when regarded strictly from a statistical standpoint, as explained in the following summary of the situation. The total stocks of this metal in the world to-day are probably the lowest for some considerable number of years, and as the "bear" account on the London Metal Exchange is now believed to be very heavy, it would therefore presumably not take much to turn this market in an upward direction. The apparent reason for the price on the London Metal Exchange having been depressed is owing to the fact of German holders having liquidated all their surplus stocks to enable them to obtain cash to show in their balance-sheets at the end of the year. Current quotations:—*Ordinary*: Wednesday, £38 6s. 3d.; Thursday, £38 11s. 3d.; Monday, £38 15s.; Tuesday, £39; Wednesday, £38 15s.

Lead.—In the market for soft foreign pig the surplus stocks in hand are such that, in the absence of any particular demand, either on the part of Continental or home consumers, the tendency has been decidedly downward. Imports for November were 19,943 tons, making a total for eleven months of 245,362 tons, as compared with 218,239 tons for the same period last year. Current quotations:—*Soft foreign (prompt)*: Wednesday, £34 15s.; Thursday, £35; Monday, £35 6s. 3d.; Tuesday, £35 7s. 6d.; Wednesday, £35 6s. 3d.

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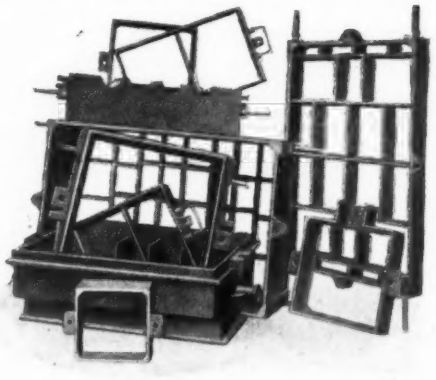

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We can save you money.

The Foundry and Engineering Co.

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ALBERT SMITH & Co FOUNDRY ENGINEERS. TOOLS & EQUIPMENT

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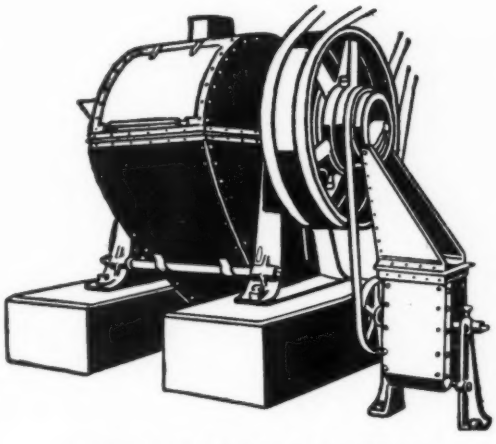

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are the last word in the Treatment of Brass Foundry

ASHES AND SKIMMINGS.

If you don't want to lose what your Competitor is saving, you must write to us about it now.

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WHITE DUST,
COAL DUST.

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PHOENIX WORKS, PENISTONE, near SHEFFIELD.

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LADLES,
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WIRE BRUSHES,
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LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES.
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	59	7	6
Three months	60	7	6
Electrolytic	65	10	0
Tough	62	10	0
Best selected	63	5	0
Sheets	90	0	0
India	75	0	0
Wire bars	66	0	0
Do. Jan.	65	10	0
Do. Feb.	65	10	0
Ingot bars	65	10	0
H.C. wire rods	70	0	0
Off. av. cash, Nov. 61	6	10$\frac{1}{2}$	
Do., 3 mths. Nov.62	6	3	
Do., Sttlmnt, Nov.61	6	5$\frac{1}{2}$	
Do., Electro, Nov.68	2	10$\frac{3}{4}$	
Do., B.S., Nov.	65	10	0
Aver. spot price copper, Nov.	61	6	5
Do., wire bars, Nov.68	7	10$\frac{1}{4}$	
Solid drawn tubes		13d.	
Brazed tubes		13d.	
Wire		10d.	

BRASS.

Solid drawn tubes	12d.
Brazed tubes	13$\frac{1}{2}$d.
Rods, drawn	11$\frac{1}{2}$d.
Rods, extd. or rlld.	7$\frac{1}{2}$d.
Sheets to 10 w.g	10$\frac{1}{2}$d.
Wire	10$\frac{1}{2}$d.
Rolled metal	9$\frac{1}{2}$d.
Yellow metal rods	7$\frac{1}{2}$d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8$\frac{1}{2}$d.

TIN.

	£	s.	d.
Standard cash	287	15	0
Three months	280	12	6
English	286	10	0
Bars	288	0	0
Straits	288	0	0
Australian	288	0	0
Eastern	288	15	0
Banca	293	10	0
Off.aver. cash, Nov.	284	14	1$\frac{3}{4}$
Do., 3 mths., Nov.	281	14	9$\frac{3}{4}$
Do., Sttlmt. Nov.	284	13	6$\frac{3}{4}$
Aver. spot., Nov.	284	13	7

SPELTER.

	£	s.	d.
Ordinary	38	15	0
Remelted	37	5	0
Hard	32	0	0
Electro 99.9	42	15	0
English	39	12	6
India	33	5	0
Zinc dust	46	0	0
Zinc ashes	15	10	0
Off. aver., Nov.	38	13	5$\frac{1}{2}$
Aver., spot, Nov.	39	0	9$\frac{1}{2}$

LEAD.

	£	s.	d.
Soft foreign ppt.	35	6	3
English	36	10	0
Off. average, Nov.	36	10	10
Average spot, Nov.	36	17	5$\frac{1}{2}$

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	46	0	0
Do. V.M. ex whf.	45	0	0
Rods	52	0	0
Boiler plates	44	0	0
Battery plates	44	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	95	0	0
Chinese	89	0	0
Crude	65	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	15	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon	
25%	£9 10 0
45/50%	£11 15 0
75%	£21 10 0
Ferro-vanadium—	
35/40%	£15/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	6/- to 6/3 lb.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%,	£20 0 0
Ferro-tungsten—	
80/85%,c.fr.	1/8 lb. to 1/8$\frac{1}{2}$
Tungsten metal powder—	
98/99%	1/11 to 2/- lb.
Ferro-chrome—	
2/4% car.	£34 15 0
4/6% car.	£23 12 6
6/8% car.	£23 2 6
8/10% car.	£22 15 0
Ferro-chrome—	
Max. 2% car.	£40 15 0
Max. 1% car.	£49 0 0
Max.0.70%car.	£56 10 0
70%, carbonless	1/5 lb.
Nickel—99%, cubes or pellets	£172 to £177
Cobalt metal—98/99%	10/- lb.
Aluminium 98/99%	£120
Metallic Chromium—	
96/98%	3/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£15 7 6
76/80%, packéd	£16 7 6
76/80%, export	£15 5 0
Metallic manganese—	
94/96%, carbonless	2/- lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 2 6
Finished bars, 18% tungsten	3 0
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. and over	4d.lb.
Rounds and squares under $\frac{1}{2}$ in. to $\frac{1}{4}$ in.	3d. lb.
Do. under $\frac{1}{4}$in. to $\frac{1}{16}$ in.	1/- lb.
Flats, $\frac{1}{4}$in. × $\frac{1}{4}$in. to under 1 in. × $\frac{3}{8}$ in.	3d. lb.
Do. under $\frac{1}{4}$in. × $\frac{1}{4}$in.	1/- lb
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.
Per lb. net, d/s steel makers' work	

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	7	6	3	10	0
Bundled steel & shrngs.	3	2	6	to 3	6	0
Mixed iron & steel	3	0	0	to 3	2	6
Heavy cast iron	3	2	6	to 3	5	0
Good machinery for foundries		3	7	6		
Cleveland—						
Heavy steel		3	2	6		
Steel turnings		2	5	0		
Cast iron borings		2	2	6		
Heavy forge		4	2	6		
Bushelled scrap		3	7	6		
Cast-iron scrap	3	0	0	to 3	1	0
Lancashire—						
Cast-iron scrap		3	10	0		
Heavy wrought		3	10	0		
Steel turnings		2	0	0		
London — Merchants' buying prices delivered yard.						
Copper (clean)		51	0	0		
Brass (clean)		39	0	0		
Lead (less usual draft)		31	0	0		
Tea lead		27	0	0		
Zinc		25	0	0		
New aluminium cuttings		92	0	0		
Braziery copper		46	0	0		
Gunmetal		46	0	0		
Hollow pewter		190	0	0		
Shaped black pewter		140	0	0		

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1	71/-
Foundry No. 3	68/6
Foundry No. 4	67/6
Forge No. 4	66/6
Hematite No. 1	77/-
Hematite M/Nos.	76/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	92/6
Midlands—	
Staffs com mon*	—
,, No 4 forge	60/-
,, No. 3 foundry	65/-
Shrops. basic	70/-
,, Cold blast, ord.*	185/-
,, ,, roll iron*	190/-
* d/d Birmingham.	
Northants forge	55/-
,, fdry No. 3	62/6
Derbyshire forge	59/6
,, fdry. No. 3	65/-
,, basic	65/-
Scotland—	
Foundry No. 1	81/6
,, No. 3	76/6
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	63/6
,, fdry. No. 3	69/-
Lincs. forge	68/-
,, fdry. No. 3	70/-
E.C. hematite	86/6
W.C. hematite	88/6
Lincs. (at furnaces)—	
Forge No. 4	62/-
Foundry No. 3	64/-
Basic	64/-
Lancashire (d/d eq. Man.)—	
Derby forge	67/-
,, fdry. No. 3	73/-
Northants foundry No. 3	75/3
Dalzell, No. 3	110/-
Summerlee, No. 3	94/-
Glengarnock, No. 3	94/-
Gartsherrie, No. 3	94/-
Monkland No. 3	94/-
Coltness, No. 3	94/-
Shotts, No. 3	94/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars(cr.)	11	5	0	to 12	10	0
Angles				11	10	0
Tees to 3 united ins.				12	0	0
Nut and bolt				10	15	0
Hoops	14	0	0	to 15	0	0
Marked bars (Staffs.) f.o.t.				14	0	0
Gas strip	12	10	0	to 12	15	0
Bolts and nuts $\frac{3}{4}$ in. × 4 in.				16	15	0
Steel—						
Ship plates	7	5	0	to 7	17	6
Boiler plts.				11	10	0
Chequer plts.	£9	5	to	9	15	0
Angles	£6	17	6	to 7	5	0
Tees	£8	0	0	to 8	5	0
Channels	£6	12	6	to 7	2	6
Joists	£6	17	6	to 7	5	0
Rounds and Squares 3 in. to 5$\frac{1}{2}$ ins.				8	7	6
Rounds under 3 in. to $\frac{3}{8}$ in.				8	2	6
Flats, over 5 in. wide and up				8	17	6
Flats, 5in. to 1$\frac{1}{2}$in.				7	17	6
Rails, heavy				8	0	0
Fishplates				12	0	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				11	5	0
Galv. cor. sheets, 24g.				16	15	0
Galv. fencing wire 8g. plain				14	0	0
Billets,soft	£6	0	0	to 7	5	0
Billets, hard				8	2	6
Sheet bars				6	5	0
Tin bars d/d				6	5	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3$\frac{1}{2}$
Wire	1	3$\frac{1}{2}$
Rods	1	3
Tubes	1	8$\frac{1}{4}$
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3$\frac{1}{2}$ to 1/9$\frac{1}{2}$
To 15 in. wide	1/3$\frac{1}{2}$ to 1/9$\frac{1}{2}$
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4$\frac{1}{2}$ to 1/10$\frac{1}{2}$
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5$\frac{1}{2}$
Ingots rolled to spoon size	1/- to 1/8$\frac{1}{2}$
Wire round—	
3/0 to 10 G.	1/6$\frac{1}{2}$ to 2/1$\frac{1}{2}$

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	24.26
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	22.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	115.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.50
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.60
Sheets, blue an'l'd, 9 & 10	2.50
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	£5.50

COKE (at ovens).

Welsh foundry	32/6 to 37/6
,, furnace	20/- to 25/-
Durham & North.	
,, foundry	30/- to 33/-
,, furnace	18/- to 18/6
Other Districts, foundry	30/- to 33/-
,, ,, furnace (basis)	11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	20/-
,,	28×20, ,,	40/-
,,	20×10, ,,	29/3
,,	18$\frac{3}{4}$×14, ,,	20/10$\frac{1}{2}$
C.W.	20×14, ,,	18/3
,,	28×20, ,,	36/3
,,	20×10, ,,	25/1$\frac{1}{2}$
,,	18$\frac{3}{4}$×14, ,,	18/7$\frac{1}{2}$

Terneplates 28 × 20, 36/- per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£19/0 to £20/0
Rolled Ord.	£16/0/0 to £16/10/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£10 to £14
Pig-iron	£6 15 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES.

Up to and incl. 6 in.

Gas .. 55% } Tube prices
Water .. 50% } are
Steam .. 45% } now free.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Dec. 23	59	12	6	dec. 7/6
,, 24	59	17	6	inc. 5/-
,, 28	59	15	0	dec. 2/6
,, 29	59	5	0	,, 10/-
,, 30	59	7	6	inc. 2/6

Electrolytic Copper.

	£	s.	d.	
Dec. 23	65	10	0	dec. 15/-
,, 24	65	10	0	No change
,, 28	65	15	0	inc. 5/-
,, 29	65	10	0	dec. 5/-
,, 30	65	10	0	No change

Standard Tin (Cash).

	£	s.	d.	
Dec. 23	286	5	0	inc. 15/-
,, 24	288	0	0	,, 35/-
,, 28	289	0	0	,, 20/-
,, 29	287	0	0	dec. 40/-
,, 30	287	15	0	inc. 15/-

Tin (English ingots).

	£	s.	d.	
Dec. 23	285	5	0	inc. 5/-
,, 24	287	0	0	,, 35/-
,, 28	288	0	0	,, 20/-
,, 29	286	0	0	dec. 40/-
,, 30	286	10	0	inc. 10/-

Zinc Sheets (English).

	£	s	d.	
Dec. 23	46	0	0	No change
,, 24	46	0	0	,, ,,
,, 28	46	0	0	,, ,,
,, 29	46	0	0	,, ,,
,, 30	46	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Dec. 23	38	6	3	No change
,, 24	38	11	3	inc. 5/-
,, 28	38	15	0	,, 3/9
,, 29	39	0	0	,, 5/-
,, 30	38	15	0	dec. 5/-

Lead (English).

	£	s.	d.	
Dec. 23	35	15	0	dec. 5/-
,, 24	36	5	0	inc. 10/-
,, 28	36	10	0	,, 5/-
,, 29	36	10	0	No change
,, 30	36	10	0	,, ,,

AVERAGE MONTHLY PRICES OF IRON HOOPS.

	Jan.			Feb.			March.			April.			May.			June.			July.			Aug.			Sept.			Oct.			Nov.			Dec.			Yearly average.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1896	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	2	6	6	5	0	6	10	0	6	3	4
1897	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0
1898	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	10	0	6	15	0	7	0	0	6	11	8			
1899	7	0	0	7	0	0	7	0	0	7	0	0	7	12	6	10	12	6	8	12	6	8	12	6	8	12	6	8	12	6	9	2	6	9	7	6	9	17	6	8	2	6
1900	9	17	6	10	7	6	10	7	6	10	12	6	7	12	6	7	12	6	10	12	6	10	12	6	10	12	6	10	12	6	9	17	6	9	2	6	9	2	6	10	3	9
1901	9	2	6	8	2	6	8	2	6	7	12	6	7	12	6	7	12	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	11	8
1902	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6
1903	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6
1904	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6	7	2	6
1905	6	17	6	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	2	6	7	2	6	7	2	6	7	2	6	7	7	6	7	0	0	7	7	6	7	1	8
1906	7	10	0	7	17	6	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0	8	7	6	7	15	10
1907	8	7	6	8	7	6	8	7	6	8	7	0	8	7	0	8	7	6	8	7	6	8	10	0	8	10	0	8	10	0	8	5	0	8	5	0	8	0	0	8	7	1
1908	8	0	0	7	10	0	7	10	0	7	10	6	7	10	0	7	10	0	7	10	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0
1909	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0	7	5	0	7	6	5½
1910	7	1	10½	7	6	3	7	7	6	7	7	0	7	7	6	7	7	6	7	7	6	7	7	6	7	7	6	7	7	6	7	6	3	7	5	0	7	6	0	7	6	1½
1911	7	5	0	7	5	0	7	5	0	7	5	6	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0	7	8	9	7	10	0	7	10	0	7	6	1½
1912	7	12	6	7	12	6	7	12	6	7	15	0	7	15	0	8	2	6	8	2	6	8	2	6	8	2	6	8	12	6	8	12	6	8	12	6	8	15	0	8	2	3½
1913	8	17	6	8	17	6	8	17	6	8	17	0	8	17	6	8	17	6	8	17	6	8	17	6	8	7	6	8	7	6	8	7	6	8	7	6	8	7	6	8	12	6
1914	7	17	6	7	17	6	7	17	6	7	13	9	7	12	6	7	12	6	7	12	6	7	12	6	9	2	6	9	2	6	9	2	6	9	2	6	9	2	6	8	6	4½
1915	9	3	6	9	18	1	10	7	6	10	16	6	10	17	6	13	2	6	13	2	6	13	2	6	13	2	6	13	7	6	14	2	6	15	2	6	15	18	6	12	10	1½
1916	17	2	6	17	2	6	17	2	6	17	6	3	17	7	6	17	7	6	17	7	6	17	7	6	17	7	6	17	7	6	17	7	6	17	7	6	17	7	6	17	6	1½
1917	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6
1918	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6	17	2	6
1919	17	2	6	17	2	6	17	2	6	17	2	6	24	6	3	24	6	3	24	6	3	25	9	0	26	7	6	26	7	6	26	7	6	26	17	4	22	14	9			
1920	28	0	0	28	12	6	33	15	0	35	5	0	35	15	10	38	17	6	38	17	6	38	17	6	38	17	6	38	17	6	38	17	6	36	17	6	36	17	6	35	14	9
1921	29	1	3	23	5	0	21	12	6	20	0	0	20	0	0	20	0	0	17	5	0	15	0	0	14	4	0	13	15	0	13	10	0	12	18	0	17	5	10			
1922	16	5	0	15	13	9	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	14	0	0	13	4	6½
1923	14	0	0	15	0	0	15	0	0	15	6	0	15	0	0	15	0	0	15	0	0	15	0	0	15	0	0	15	0	0	14	16	0	14	15	0	14	18	3½			
1924	14	15	0	14	15	0	14	15	0	14	15	0	14	15	0	14	13	9	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	12	4½			
1925	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0	14	10	0			

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

STEEL FOUNDRY MANAGER AND METALLURGIST, desirous change; seven years present position; excellent Foundry record; experienced Tropenas Converter and Siemens.—Box 552, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CHEMIST AND METALLURGIST, with many years' practical Foundry experience, desires post in connection with Foundry; highest references.—Apply Box 566, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

STEEL FOUNDRY MANAGER; disengaged; experienced with the following plants: Siemens, Tropenas, Stock Oil Converter, and eight years' experience with the Electric Furnace Process; understanding the manufacture of Steel Castings from A to Z at a very keen cost of production, either piecework or timework; having also a fair connection; excellent references.—Box 568, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WELL-KNOWN LANCASHIRE FOUNDRY MANAGER desires change; first-class practical man, accustomed to large output Electrical, Turbines, Diesel and General Engine Castings up to 35 tons; well up in modern practice; excellent Cupola and Metallurgical knowledge; 15 years' experience as manager; good organiser, good control; accustomed piecework; excellent references; age 43 years; or would entertain offer from Foundry Requisite firms.—Apply Box 564, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN wanted, experienced in making Radiators and Small Castings essential.—Apply, stating full particulars, to T. H. PICKLES & SONS, LTD., Radiator and Boiler Makers, Mytholmroyd, nr. Halifax.

BRONZE FOUNDER, capable of casting bronze figures by cire perdu method, required for Australia by COMMONWEALTH GOVERNMENT. Must be able to carry out whole process from reproduction in wax of plaster casts to finished work in chased bronze. Contract up to 30th June, 1929, essential.—Apply, with full particulars, qualifications and experience, to OFFICIAL SECRETARY, Australia House, Strand, London.

BUSINESSES FOR SALE AND WANTED.

IRON FOUNDRY, near London, well equipped with Electric Light and Power, Cupolas and Machinery, Cranes, Tramway, and Ladles; 2 tons daily; Freehold and Goodwill as going concern, £2,500; boxes, patterns, and stock optional extra.—Box 570, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, London, W.C.2.

EXCELLENT COMMODIOUS BUSINESS PREMISES (immediately available) for Sale or to Let in important position in Walsall, containing 4,356 square yards or thereabouts, and formerly used as a Foundry and Engineering Business, but equally adaptable to other trades or industries. The premises can be divided into two portions if so desired.—For further particulars apply E. IRWIN MILLER, Solicitor, Bridge Street, Walsall.

PATENTS.

THE Proprietors of the Patent No. 137,574 for Improvements in Steel Smelting Furnaces are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to HASELTINE LAKE & COMPANY, Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

MACHINERY.

"OLIVER." No. 75. MECHANICAL PATTERN MAKER, and Universal Wood Milling Machine, second-hand, but having had little use, is equal to new, complete with full set of tools, accessories, etc.; great bargain at very low price; photo.—Apply, FRED BROWN & SON, LIMITED. North Road Works, St. Helens.

FOR SALE.—20-in. and 24-in. Hall's Invincible Sand Mixers; the original and best machine in the market for mixing old and new Foundry Sand, Coal Dust, etc.—Apply, PENNEY & PORTER (ENG.), LTD., Lincoln.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LTD., Russell Street, Sheffield.

MACHINERY, PLANT, &c.

New 16-in. stroke HIGH-SPEED SLOTTING MACHINE, by Wilkinson, admits in diameter 5 ft.

24-in. stroke TRAVERSING HEAD SHAPING MACHINE on 8-ft. bed, two tables 24 in. x 18 in. x 16 in. deep.

No. 70½ INTERNAL GRINDING MACHINE, by Heald Machine Company, capacity 15 in. swing, 11 in. long.

SET OF GUILLOTINE SHEARS, by J. Hand & Son, style C.D. No. 3, 36-in. blade to cut 3/16 in. thick.

LANCASHIRE BOILER, 30 ft. x 7 ft. 6 in. dia., reinsure 120 lbs. pressure.

Very good second-hand VERTICAL CROSS-TUBE BOILER, 14 ft. high x 6 ft. dia., reinsure 110 lbs. working pressure.

CATALOGUE (10,000 LOTS) ON APPLICATION.

THOS W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. Phone 264.

WHEN IN DOUBT send your orders or inquiries for Materials and Requisites for Iron and Brass Foundries to WILLIAM OLSEN, LIMITED, COGAN STREET, HULL. Largest stock; prompt deliveries; carriage paid terms.

TENDER.

BARKING TOWN URBAN DISTRICT COUNCIL.

ENGINEER AND SURVEYOR'S DEPARTMENT.

SECOND-HAND TRAMWAY RAILS.

Lump-sum offers are invited for approximately 60 tons of old Tramway Rails as they lie on the Council's Wharf, Gascoigne Road, Barking.

Form of offer and full particulars can be obtained upon application to Mr. R. A. Lay, Assoc.M.Inst.C.E., the Engineer and Surveyor, Public Offices, East Street, Barking, Essex.

Offers should be forwarded in the special envelope provided for the purpose, so as to reach the Engineer and Surveyor not later than 9.30 a.m. on Friday, the 15th January, 1926.

The Council do not bind themselves to accept the highest or any offer.

By Order,
H. HARGREAVES,
Clerk to the Council.

Public Offices,
Barking.
28th December, 1925.

CUPOLAS

4'-6" THWAITES, new condition, with spark arrester and receiver, built 1921, little used, at Slough ..	£95
3'-0" CONSTRUCTIONAL, nearly new, ready immediate delivery (at Slough)	£48
2'-6" CUPOLETTE, with fan and pipes	£26

LADLES

12 Ton EVANS, practically unused	£85
5 Ton STEVENSON, as new	£45
3 Ton THWAITES, NEW, UNUSED	£32
2½ Ton EVANS, good as new	£26
1½ Ton EVANS, NEW, UNUSED	£24

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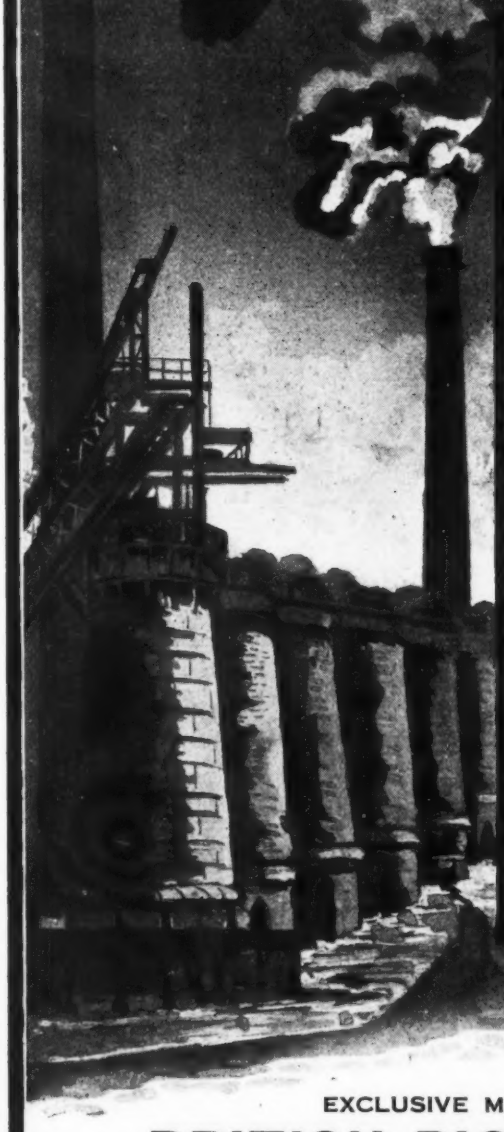
FOUNDRY MACHINERY MERCHANT,
"BOXTED," SLOUGH.

MIDHILL AND GLENHILL

SPECIAL PIGIRONS



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UNIQUE

Acknowledged by the World's leading Foundries to be pre-eminent as a Core-making medium.

GLYSO LESSENS YOUR SCRAP OUTPUT

APPLY FOR FULL PARTICULARS TO THE SOLE MANUFACTURERS:

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Advantages:

Immunity from Sparks and Grit.

Avoids damage to Roofs, choking up of Gutters.

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Important Labour Saver.

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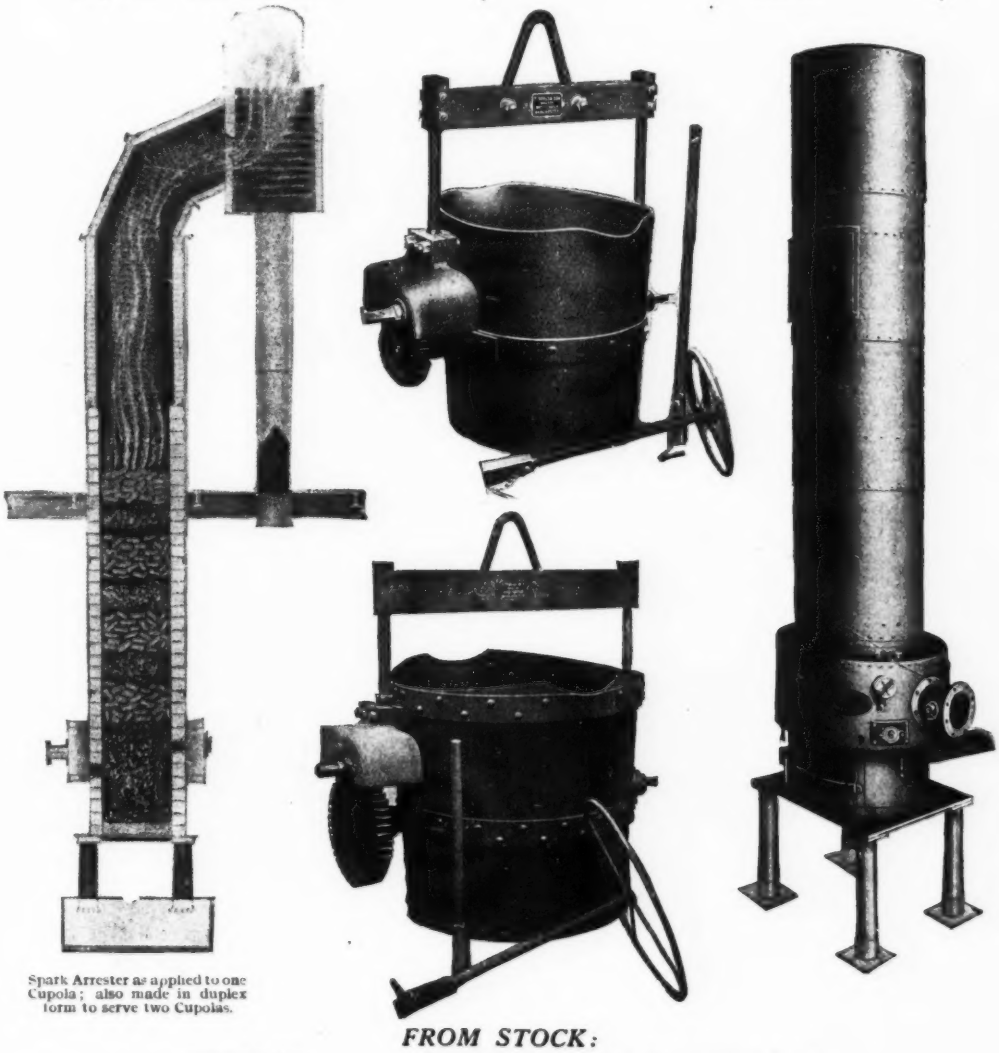

Spark Arrester as applied to one Cupola; also made in duplex form to serve two Cupolas.

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CUPOLAS.
STAGING
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SAND BLAST PLANT.
PATTERNS.
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We beg to announce our having purchased the constructional plant of

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LIMITED,

Bradford.

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As is well known, the selection of this plant is the result of years of experience in the manufacture of Cupolas, Ladles, Stagings, etc., and will be of considerable assistance to us in the manufacture of these products, and in making a first-class job.

It is our aim to supply the above manufactures at a reasonable price, and we shall look forward to receiving some of your enquiries.

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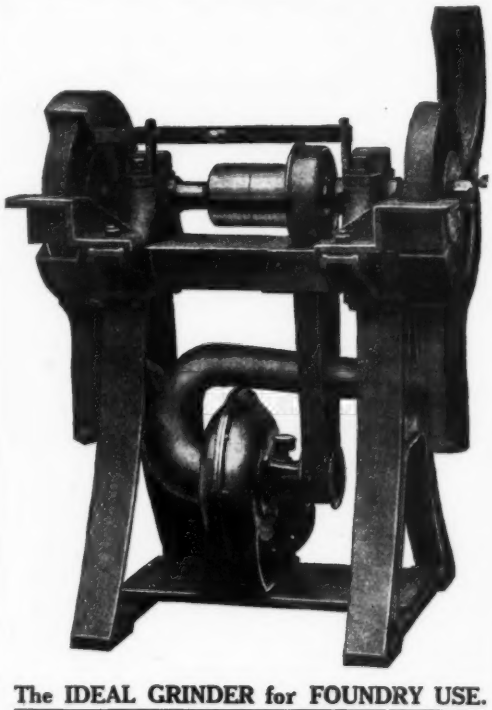

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	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Mottled and White
Combined Carbon ..	0.59	0.56	0.65 to 0.70	0.50 to 0.75	0.65 to 0.75	0.80	2.80 to 3.90
Graphite ..	2.94	2.96	2.85 to 2.94	2.70 to 2.80	2.60 to 2.70	2.00 to 2.40	Nil
Silicon	1.30 to 1.50		1.20 to 1.50	0.80 to 1.20	0.50 to 1.10	0.45 to 0.70	0.45 to 0.50
Sulphur	0.042 to 0.07		0.02 to 0.08	0.04 to 0.10	0.15 to 0.07	0.15 to 0.12	0.17 to 0.20
Phosphorus ..	—		0.35 to 0.45	0.35 to 0.50	0.35 to 0.50	0.35 to 0.50	0.35 to 0.50
Manganese ..	—		1.20 to 0.90	0.70 to 0.95	0.65 to 0.85	0.70 to 0.80	0.40 to 0.25

LOW MOOR IRON WORKS
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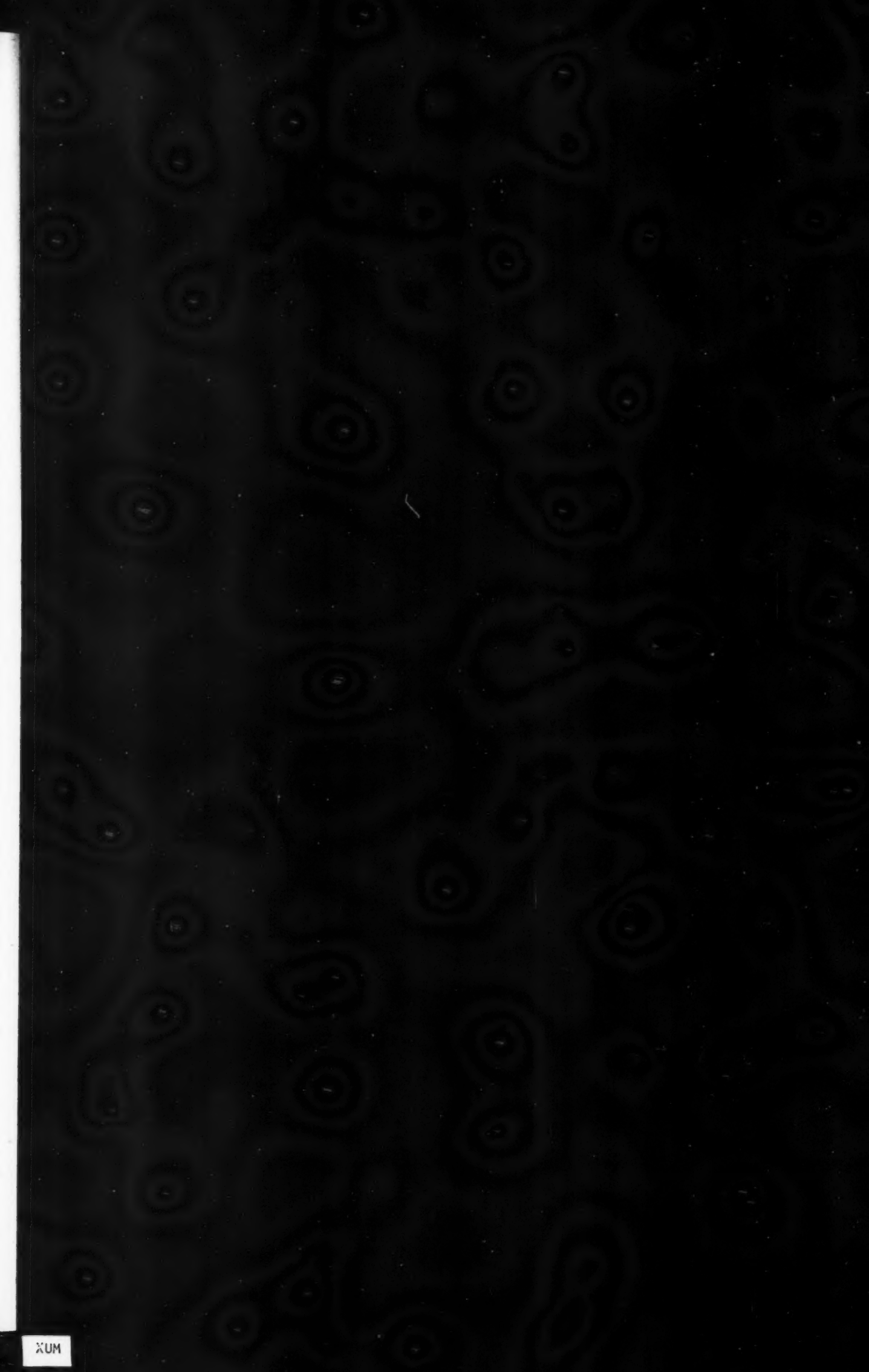
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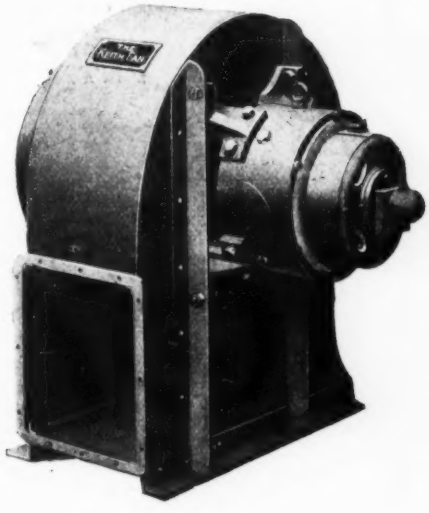

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"In each of the years 1922, 1923 and 1924 you supplied to our Rocky Lane Works complete melting plants for malleable iron. We should like to express to you our complete satisfaction at the way the work was carried out in each instance, and also for the efficiency of the plant since its instalment."

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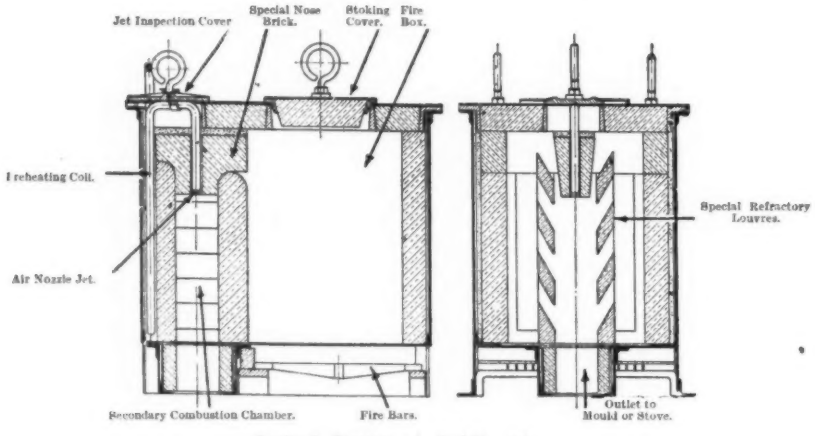

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The OEHM'S Patent Heating Element is the simplest and the most efficient apparatus yet devised for producing high temperatures by the conversion of solid fuel to CO_2 gas, possessing pressure and velocity without flame and without smoke.

For Core and Mould drying on the floor, in Pit or Drying Room. For Heating Ladles, Shanks, Ingots, etc. For Annealing and all Heat Treatments.

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Simplicity of design. **Adaptability.**

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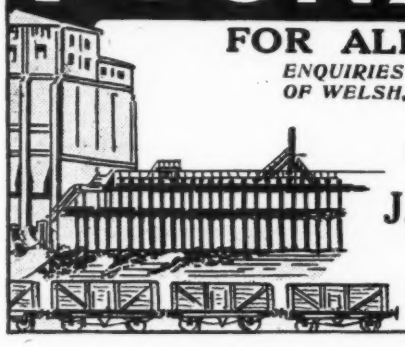

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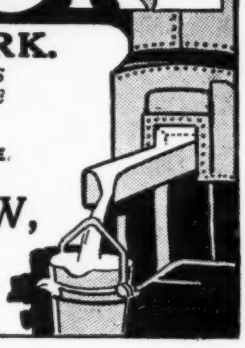

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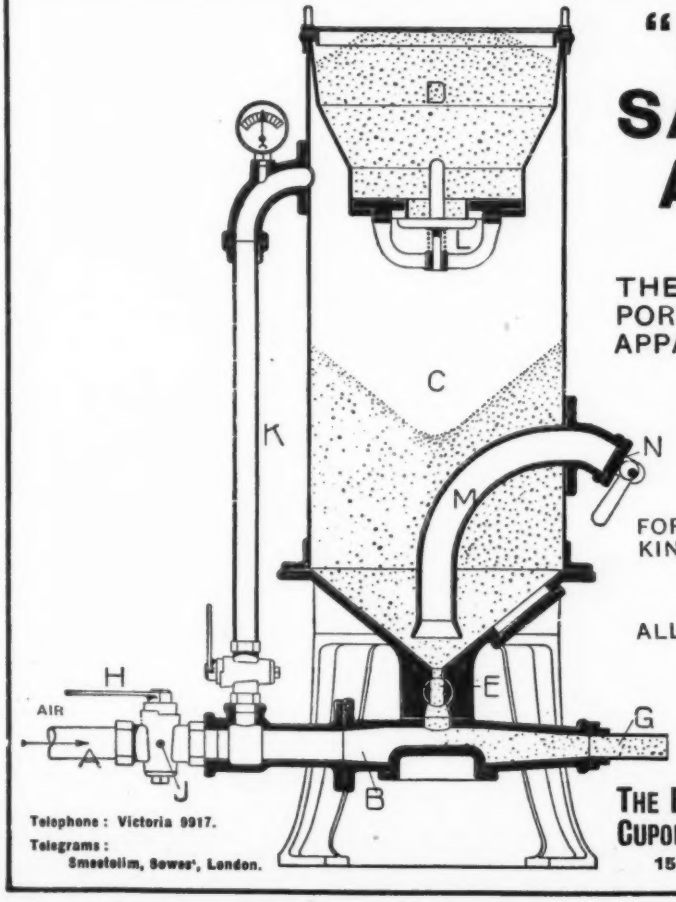

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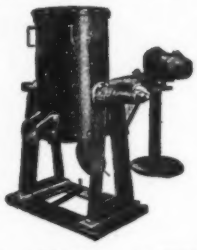

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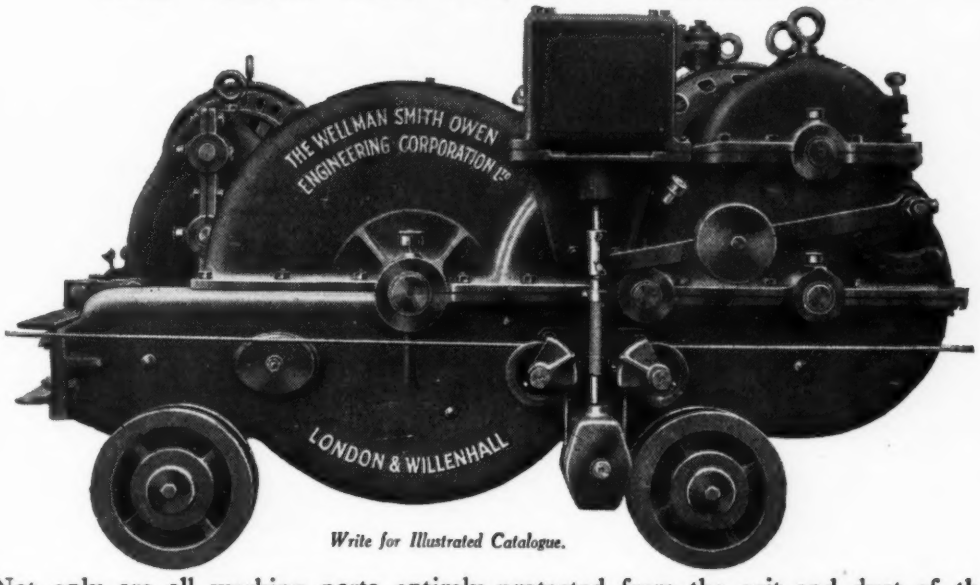

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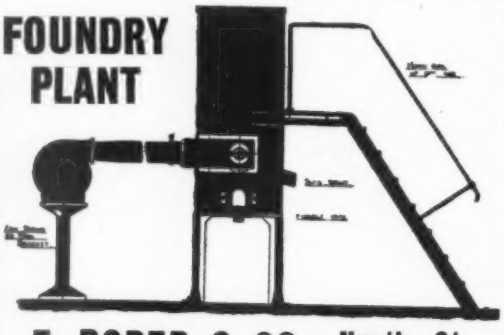

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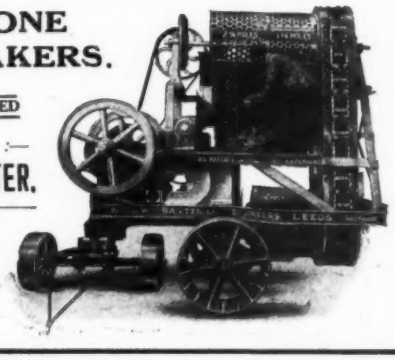

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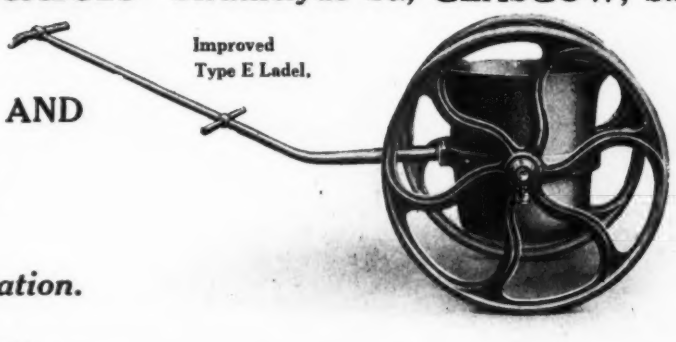
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